

Missouri Builds Experimental Types of Highway Resurfacing

Four Types Under Test Near Joplin—Four-Inch Reinforced Concrete Slab One of Types—Details of Design and Construction

DURING the past construction season the Missouri Highway Department built a 2-mile section of experimental resurfacing, using four different types of resurfacing material. The success or failure of each of the four types will furnish a guide for future resurfacing work in Missouri. Three of the sections each had a length of $\frac{1}{4}$ mile; the fourth, $1\frac{1}{4}$ miles. The longer section is a type of penetration macadam called retread. The others are asphaltic concrete, Oklahoma rock asphalt, and 4 in. of reinforced portland cement concrete.

The section resurfaced is the 2 miles south of the city limits of Joplin, on U. S. 71. The old pavement was 18 ft. wide and had 6-in. edges and a $7\frac{1}{2}$ -in. thickness at the center. As it had no center joints it had cracks quite generally longitudinal, while the thin edges had caused considerable breakage. The original pavement was built without regular transverse joints and the consequent transverse cracking had been rather irregular.

Concrete Section of Two Types

The $\frac{1}{4}$ mile of concrete resurfacing was divided into two sections. On one the bond between the new concrete and the old pavement was prevented by applying a coating of asphalt about $\frac{1}{8}$ in. thick to the old pavement. The asphalt was put on with a distributor. On the other half of the concrete portion it was attempted to secure the best possible bond by scrubbing the old pavement thoroughly with brooms and water and applying the new concrete to the wet, scrubbed surface.

Materials were proportioned 1:2:3 $\frac{1}{2}$ and batches were measured by weight at a central proportioning plant. The coarse aggregate was crushed limestone with maximum size of $1\frac{1}{2}$ in. and the fine aggregate was river sand.

Levels were first run on the edge of the old pavement and a grade was established which would yield the desired thickness of resurfacing material and at the same time give a smooth-riding surface. The steel side forms were set at this grade just beyond the edge of the old pavement.

Expansion Joints in Resurfacing Layer

The only joints in the old pavement were construction

joints made at irregular noon and night stops. In the resurfacing layer 1-in. expansion joints were spaced at 80-ft. intervals, and contraction joints midway between them made a slab length of 40 ft. The expansion joints were made with premolded strips of expansion joint material held in place by a steel bulkhead that was held truly



Dowel bars $\frac{3}{4}$ in. in diameter, spaced at 2-ft. intervals, extend across all expansion joints

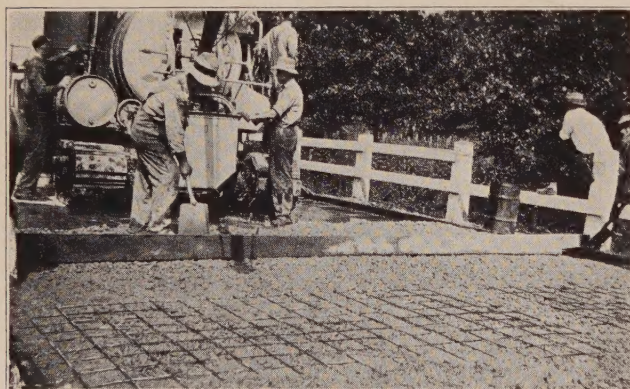
vertical by three brackets. Concrete was placed on both sides of the bulkhead and over the top of the expansion joint material and the finishing machine worked right over the top of the joint. After the preliminary finishing was completed the bulkhead and brackets were removed, concrete was removed from above the expansion material and the joint was edged.

Transverse Contraction and Longitudinal Joints

Both the transverse contraction joints and the longitudinal center joints were made by impressing a groove $\frac{1}{2}$ in. wide and $1\frac{1}{4}$ in. deep in the concrete. The grooves were made by pushing the web of the standard T-bar into the concrete after it had hardened just a little so that it would not flow back and fill the groove.

Methods Used

As the limestone aggregate made a concrete which would not push away readily, the T-bars had to be driven into the concrete with a wooden maul. The T-bar was removed as soon as the groove had been made and the space left was immediately filled with a strip of pre-molded bituminous joint filler which was put in by hand. Round steel bars $\frac{3}{4}$ in. in diameter and 5 ft. long were



Mesh was placed $1\frac{1}{2}$ in. from the top of the slab by striking off the concrete at that depth

used as dowels across transverse joints. They were spaced 2 ft. apart. Holes were cut through the joint material at the exact center, since it is important when slabs are thin that the dowel does not come too near the top or bottom of the slab. Concrete was allowed to bond with the dowel in one slab but the half in the other slab was encased in a metal sleeve, the end of which extended 4 in. beyond the end of the dowel. This 4 in. was filled with loosely wadded paper so that a space was provided into which the dowel bar could push as the joints closed. Workmen made sure that the end of the sleeve next to the expansion joint was firmly against the joint material so that no part of the sleeve end of the bar was bonded to the concrete. Dowels of the same dimension and spacing also extended across the dummy contraction joint. As no space was required at the end of dowels at contraction joints, sleeves were omitted and slippage was assured by greasing the entire bar. Bars for the contraction joints were set ahead of the concrete in exactly the proper position.

Center Joint

The longitudinal center joint was also of the dummy type and was made in the same manner by driving the

web of a T-bar into the concrete. Tie bars 4 ft. long and $\frac{5}{8}$ in. in diameter, spaced 5 ft. apart, extended across this joint. They were set on chairs in the exact position on the subgrade ahead of the concrete.

Reinforcement of Wire Mesh

The pavement was reinforced with wire mesh weighing 59 lb. per 100 sq. ft. with wires spaced 6 in. apart in both directions. A 6-in. space was left between the ends of sheets at expansion joints and where the dummy contraction joints were to be installed. A 6-in. space was also left between sheets along the center line where the longitudinal dummy joint was to be put in. At first the reinforcement was held in the proper position $1\frac{1}{2}$ in. below the upper surface of the pavement by laying it on mounds of concrete deposited ahead of the concreting. This method was found unsatisfactory because workmen walked over the mesh, and forced it out of its proper position. Consequently the more satisfactory method was adopted of striking off a layer of concrete $1\frac{1}{2}$ in. below the surface, placing the mesh on this layer, and depositing concrete over it to the full depth of the slab.

Acknowledgments

The work was done under the supervision of the State Maintenance Department, with Paul B. Lee, project engineer, in direct charge of the work. The Doboise Construction Company, of Pittsburg, Kansas, were the contractors. As it takes some time for a test road of this sort to show its true value, it was built before any actual resurfacing work was contemplated.

He Studied the Fireproofing of Steel Framed Buildings

A contractor in a large city considered the possibilities of becoming a specialist in his own city in the business of sub-contracting for the concrete fireproofing of steel frame buildings.

He knew that in New York City this work has become so highly specialized that general contractors find it more economical to sub-let the work than to do it with their own forces.

Accordingly, he sent his best construction superintendent to New York last January, with instructions to get all the information he could on methods and costs.

With the judicious use of his eyes, his ears and his notebook, supplemented by the ability to make friends, the construction superintendent collected valuable data on all phases of the work involved in the fireproofing of steel framed floors with cinder concrete.

Beginning in an early issue of "Concrete," and running through several installments, he will tell the entire story to our contractor readers.

How Movable Forms Are Taken Down

Preparations for Removal and Actual Procedure—Main Problem Is Removal of Inner Forms—Build Inside Working Platform Suspended from Roof Deck

By RICHARD T. MCKAY¹
Masonite Corporation, Chicago, Illinois

THE task of dismantling and taking down movable forms after they have been pulled to the top of the tanks or workhouse, as the case may be, is an especially dangerous one and requires constant caution on the part of the workmen.

The method of removing them also requires considerable ingenuity, bearing in mind that this work must be performed at a distance of from 100 to 200 ft. above grade on an average size job.

The method outlined in this article may not be standard practice among all contractors specializing in this type of work, but it is feasible and is quite commonly used.

Preparations for Removal

When the forms have been pulled to their highest required elevation and the concrete placed in them, holes are drilled through the forms and the recently placed concrete and bolts are inserted completely through the form and concrete wall. One bolt is placed through the form for each jack that has been used (Figure 12).

At this time also (when the forms have been jacked to their highest elevation) the 5 by 3½ by ¾-in. L's bolted

to the 16-in. I-beams are moved in position so that they take their final position in the walls. This detail is shown in Figures 3 and 4 on pages 13 and 14 of the April issue of CONCRETE.

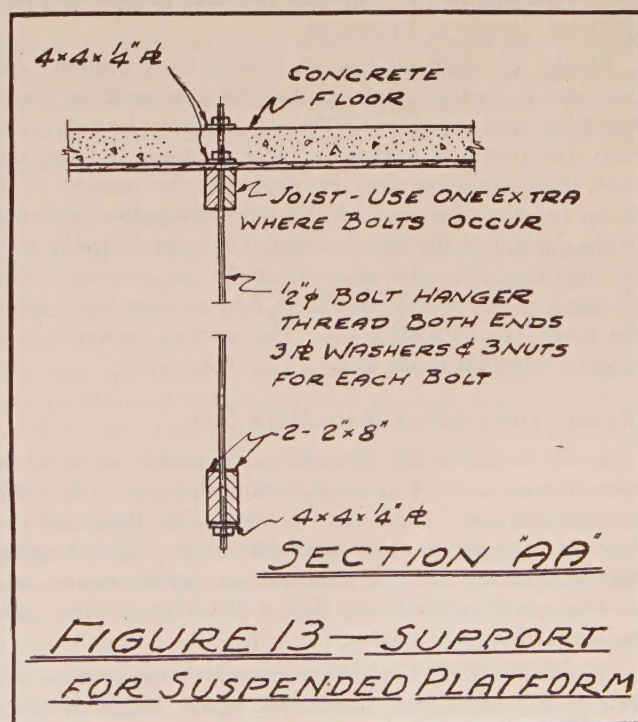
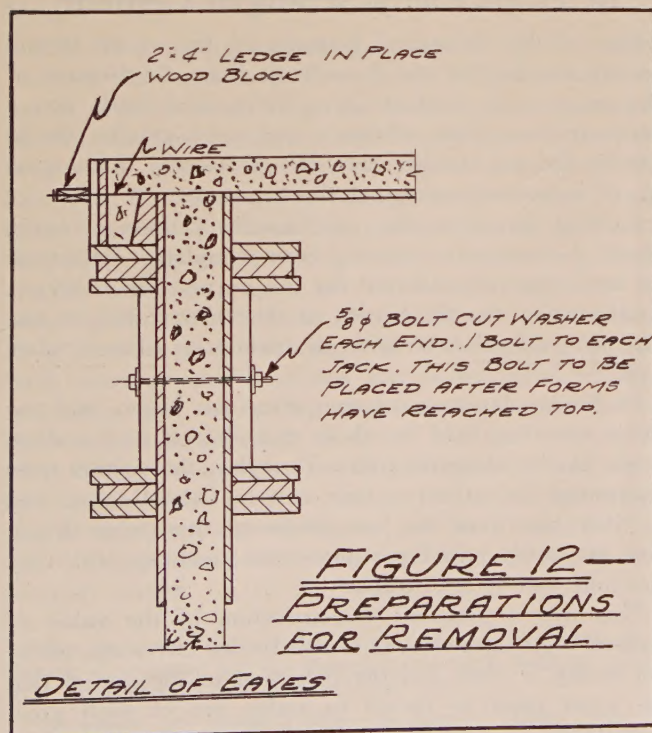
As soon as the concrete becomes hard enough to carry the forms, through bearing under the bolts and L's, the jacks are removed and the jack rods cut off at the top of the wall.

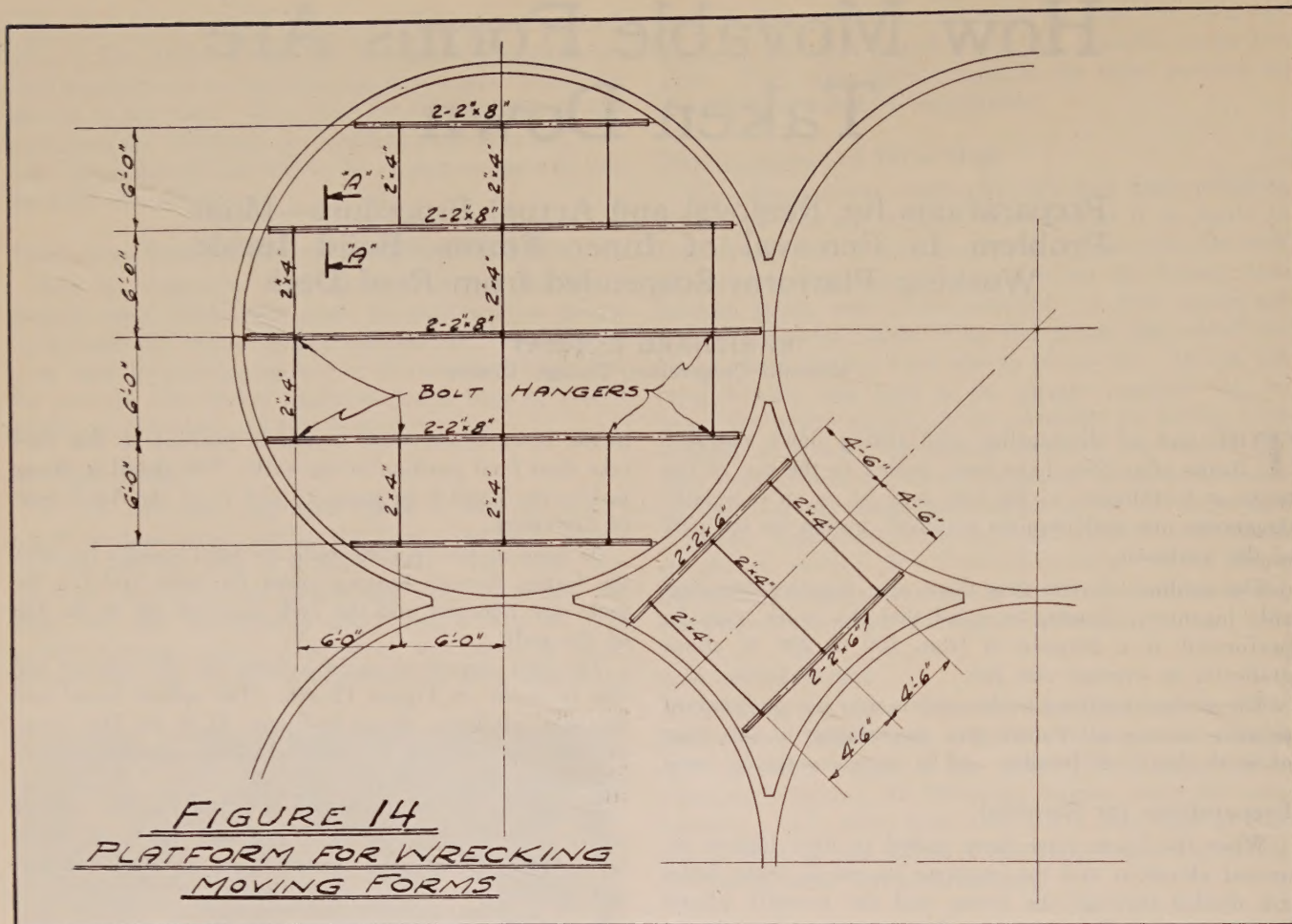
The next step is to build a form for the cornice and this is shown in Figure 12 also. The splash board and finishers' platform, shown in Figure 11 in the May issue, on page 36, can now be removed. This requires no skill but considerable caution.

As soon as the reinforcing steel is in place the cornice and roof deck slab can be placed and the work of the forms is at an end. The outside forms are then loosened and let down.

Removing the Inside Wall Forms

With the roof slab in place, the inside wall forms and the deck form, on which the roof slab was concreted, are inaccessible except for the fact that the roof slab always contains manhole openings through which grain is later spouted.





Figures 13 and 14 show in detail how a platform can be hung inside the tanks to facilitate the stripping of these forms. These figures are self-explanatory, showing as they do, the $\frac{1}{2}$ -in. hanger rods and how they are fastened into the roof slab, and also how timbers are bolted to them (see Figure 13) and how they are located in plan, the latter shown in Figure 14.

Planks are laid on top of these 2-by-8 timbers and comprise the actual platform that the men work on while removing the inside forms. These forms must be very carefully removed and passed up piece by piece through the roof slab manholes, then let down on the outside. The forms can not, of course, be allowed to drop down because of the damage to the tank bottoms. The most desirable way of removing these forms is to make the owner of the elevator an allowance and have him remove them after the tanks are full of grain. The owners, however, are usually reluctant to do this.

Placing Deck Above Main Deck Slab

It is sometimes, though seldom, desirable to build a concrete-placing deck above the main deck slab. Then the concrete buggies can be run on this higher deck and the concrete spouted down to the wall forms. This enables the men working the jack rods and placing the reinforcing steel to work on the lower deck without interfering with the concrete men.

On some recently built elevators and storage tanks, the wall forms have been lined with $\frac{1}{8}$ -in. tempered fiber board, a specially treated manufactured wood board em-

ployed in concrete form work, as a means of improving the smoothness of the surface.

New York State Mayors Shown Value of High-Early-Strength Cement

One of the interesting features of the twenty-second annual meeting of the New York State Conference of Mayors, recently held at Glens Falls, New York, was a demonstration of the efficiency and quick results obtainable by the use of high-early-strength cement in the paving of important municipal thoroughfares.

Garfield Street, in that city, was in process of being paved, the excavation having been completed. However, the concreting was delayed for the purpose of making a demonstration for the benefit of the visiting mayors and other city officials who were in attendance at the conference.

On Wednesday morning concreting was begun, and one block was completed by about two o'clock in the afternoon. On the succeeding day, Thursday, the visitors were entertained by an automobile trip to Lake George, and on their return in the late afternoon they were driven over the newly paved portion of the roadway, which by that time was open to traffic.

This was a practical demonstration of the value of high-early-strength cement, especially for city work, where the saving of time and the reduction of the period that the street must be closed to traffic are of such great importance.

Digging Tomorrow's Profits Out of Yesterday's Experience

Number of Concrete Products Plants Must Be Reduced
—Consolidations the Logical Solution—Increase Combined Business Through Diversification

By AUSTIN CRABBS
President, The Cement Products Company, Davenport, Iowa

IT is now more than a year and a half since business reached the peak of 1929. So let us see what we of the concrete products industry may have learned in this school of experience. First, we have found out that the post-war housing shortage was not a permanent proposition, but that housing facilities in a comparatively few years caught up with demand. Thus those of us who were supplying concrete blocks for foundations only got the first jolt—there were practically no more foundations being built and overhead began to eat us up. Those of us who went a step farther and worked our way "above grade" didn't get hit quite so hard or quite so soon, but the effects were gaining on us none the less surely.

Taking On Side Lines

Many saw the writing on the wall and anticipated the time when enough concrete blocks could not be sold to cover fixed charges. They added other products, such as burial vaults, roofing tile, drain tile, or some of the numerous other articles made of cement and aggregate and that go to make up a diversified concrete products plant. In many cases these items, perhaps started as side lines, have proved a valuable source of revenue, offsetting, at least to some extent, the loss of revenue from concrete blocks.

Still other companies have gone outside of the concrete products field and have taken up such lines as sand and gravel, cement and lime, and other mason materials, which do in fact fit right in with concrete products. Even brick and other clay products have been profitably handled. If it is true that you can perform a service to your community in the sale of mason materials and brick, then other lines not so closely related to concrete products can be added to round out the organization, show an added profit, and increase your ability to serve. Many have already tried out this idea with varying success. Such items as steel windows, fire doors, metal building specialties, and reinforcing steel, merely suggest the unlimited field from which to draw.¹ In our opinion the only factors to consider are the possibility, determined by careful analysis, of increasing profit through expansion of this kind, and whether or not there exists for any item a logical field that is not already sufficiently and properly served.

¹Paper presented before joint annual meeting of the Concrete Masonry Association and the Wisconsin Concrete Products Association, Milwaukee, Wis., February 23-24, 1931.

²See article by Austin Crabbs, in August (1930) issue of CONCRETE, pages 17-19.

The Major Problem of Overproduction

This brings us to the major problem, not only of our industry but of practically all industries. That is overproduction, overproductive capacity, production in excess of our ability to distribute properly, or whatever you may choose to call it. The fact remains, in our particular case, that we have far too many concrete products plants in the United States. To state that there are twice as many as there should be, may be too conservative; but economic law, in spite of our ignorant struggles of opposition, seems to tend toward the point where the final number of productive units remaining after the so-called struggle for the "survival of the fittest" has neared its end, is that number that can produce best and most economically. At present the localities are few, if any, where concrete products could not be sold either cheaper if there were fewer plants, or at a profit where excessive competition now is spelling losses for the present excessive number of manufacturers. Too many products plants in any given community means one of two things. Either the public is paying more than it should, or profit, the legitimate aim of all business, is non-existent. The mystery is that so many seem to think there should be some way to increase prices. Any price above an economic minimum can no more be permanently maintained than a business operating at a loss can continue to exist. Therefore, as we now have too many factories to allow all to exist without maintaining artificial prices, we face a further reduction in the number of concrete products plants in this country.

We Have Not Learned to Co-operate

Why should we let ourselves be the victims of economic law? Why can we not use it as a tool to greater achievements instead of being broken by our futile opposition to forces we can not conquer and tides we can not stem? Because, in spite of all our present-day education, we have not yet learned to co-operate. No one wants to see a business fail, for economic loss always results, and with more or less far-reaching effects. What then is the solution? Co-operation! And this co-operation should take on an added meaning. We not only should work together in research, in the study of plant design and operation, in advertising, and in the numerous other things that can be done jointly. Above all, we should co-operate, particularly in our own local groups in an effort to put the concrete products business on a sound financial basis, even though this may mean personal sacrifice in particular cases.

Perhaps I can best tell what I mean by citing the experience of our banks at Davenport, Iowa. You know we all expect our bankers to be rather keen business men, and we probably should look to them for advice or follow their example more often than most of us do. In Davenport we are rather proud of the fact that there has never been a bank failure. This is not a mere accident, or because Davenport has been lucky in this respect, but because our bankers have learned to work together. Not so many years ago there were too many banks in Davenport. With business becoming more and more complex, it was impossible for all to continue to make a profit; but instead of continuing the struggle till one or more went down, they realized before it was too late that through co-operation their problems could be figured out. Mere co-operation did not solve the problem of too many banks for the community; but it was only a short step from working together to getting together, and actual consolidations were the logical results. We now have six banks, two of which are counted among the largest and strongest of the middle west.

Consolidation and Diversification

We of the concrete products industry may well take a lesson from this experience. In many localities there are plants that logically could be combined, with a resultant saving in operating and overhead expense. Some equipment and even some personnel might have to go to the discard; but if a strengthened position results, we are acting in accord with economic law. Such a course eventually will prove worth the cost. Why is it so hard to co-operate with our competitors to the point where we could sit down together in a straightforward, businesslike way and figure out the advantages and disadvantages of consolidation or some other method of decreasing the number of plants? Any lawful method of accomplishing this result surely is better than a decrease through financial failure. From my experience in the concrete products industry, local meetings have paid too much attention to the question of trying to get a better price and too little or no attention to ways and means of accomplishing price reduction through efficiency and proper co-ordination. This price reduction should not mean lesser profits, as our balance sheets surely should be made to show up better than they have the last few years. My suggestion would be, if you have a friend in the local industry whom you feel you could work with, or if you believe another plant could logically be combined with yours, talk it over with the owner and see just what advantages would accrue. Any lawful means of decreasing the number of plants is a step in the right direction. If consolidations result from such conferences, perhaps a cut in personnel could be avoided by adding other lines not previously handled by either firm.

In any event we must find some way to decrease our number. Think how foolish it is to expect the public to pay the bill for five or six salesmen trying to sell blocks for one little foundation. We all have seen such instances many times.

The Way Out

To summarize the situation, our way out lies in diversification, consolidation or elimination, or a combination

of the three, and the sooner we recognize the seriousness of the problem, the better it will be. We should recognize our weaknesses and face the correction of them courageously. We must realize that progress spells the making of the best possible article at the lowest possible cost. Profit depends on captivating the fancy of the public at prices that they feel they can afford to pay. Finally, "Net profits will be cut out of operating expenses, rather than squeezed out of reluctant ultimate consumers." Well may we write this on the wall before us and make it our slogan for the future.

Uses of Reinforcing Steel in Concrete Pavements

Function of Steel—Longitudinal Center Joints Relieve Stress—How Joints Are Built

By CLIFFORD OLDER

Consulting Engineer, Chicago, Illinois

THERE are a number of exceedingly important uses for steel in the permanent construction of pavements, whether entirely of concrete or whether constructed of concrete for a base and other types of surface for the traffic use.

Purpose of Steel

The use of steel in paving slabs in a certain sense is reinforcing steel in that it may be so used as to reduce the stresses which the concrete must otherwise bear. In the Bates test road, having found that our slab at times was supported only at the edges and having reached the conclusion that it would be uneconomical to attempt to reinforce it completely, we decided upon the simple expedient of cutting the span length in two. That is, we split the 18-foot slab down the middle and had two 9-foot slabs, and did not endanger traffic. By that very simple expedient we reduced the stresses very greatly in the slab itself.

How Longitudinal Joints Are Built

After finding this out we could still produce and construct a balanced design by thickening the outer edge of the pavement and not thickening the inner edge, but doweling it thoroughly to the thickened outer edge. To accomplish this purpose, the simplest means when the Bates road was constructed was to place on edge a metal strip having longitudinal corrugations, and then tying the two slabs together with transverse tie-bars so that the tongue-and-groove effect which was produced would always mesh. The slabs would not work apart and break this mesh. We found by test, before we ever used it, that this kind of design was efficient and would effect a transfer of load from one slab to the other; in other words, it had a shearing effect.

The transverse tie-bars across the center joint of a paving slab should be figured on the basis of the coefficient of friction to the weight of the slab. If that is done, the quantity of steel acting as tie-bars will be about double the amount that is ordinarily used for this purpose.

From a paper read before the Seventh Annual Meeting of the Concrete Reinforcing Steel Institute, Biloxi, Miss., March 16-18, 1931.

Test Ready-Mixed Concrete Conveyed From Central Mixing Plant

Concrete Transported $2\frac{1}{2}$ Hours in Agitator Body—
Samples Taken Every 30 Minutes—Slump Decreased
and Strength Increased Progressively During Entire
Test Period

By WILLIS A. SLATER

Director, Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa.

TESTS have been made at the Fritz Engineering Laboratory of Lehigh University to determine the effect on the properties of concrete, of transporting it for $2\frac{1}{2}$ hours in a truck whose container consists of a closed rotating drum without mixing blades. Samples were taken at $\frac{1}{2}$ -hour intervals; on these were made tests of slump and composition of the concrete. Compressive strength specimens also were made for tests at different ages.

Strength Increases, Slump Decreases

Within the limits detected by the measurement, the concrete retained the water and all its cement throughout the $2\frac{1}{2}$ -hour transporting period. There was considerable decrease in slump and evidence of pulverizing of a considerable quantity of aggregate. The stiffening which occurred within the first hour would improve the consistency of the concrete for almost any purpose. Even after $2\frac{1}{2}$ hours in the drum, the consistency would be quite satisfactory for road and pavement work where the requirements are quite rigid. There was no evidence of segregation during the period of transporting.

The strength of the concrete from samples taken at successive intervals after charging the conveyor drum increased progressively according to the length of time during which the sample had been transported in the conveyor. The average 28-day strength of specimens taken after $2\frac{1}{2}$ hours of transporting was about 900 lb. per sq. in. higher than that taken from the mixer. The average slumps and compressive strengths of samples from Series A, B, C and D are shown in the diagram.

Acknowledgments

The concrete used in the tests here described was transported in a conveyor recently placed on the market by the Clinton Motors Corporation. The tests were made under the direction of the author. The weighing of all materials was in charge of C. C. Keyser, and the making of the control cylinders in charge of G. W. Parkinson, both of the Fritz Engineering laboratory staff. W. M. Dunagan, of Iowa State College, was employed by Lehigh University to take charge of the tests made to determine the composition of the freshly mixed concrete.

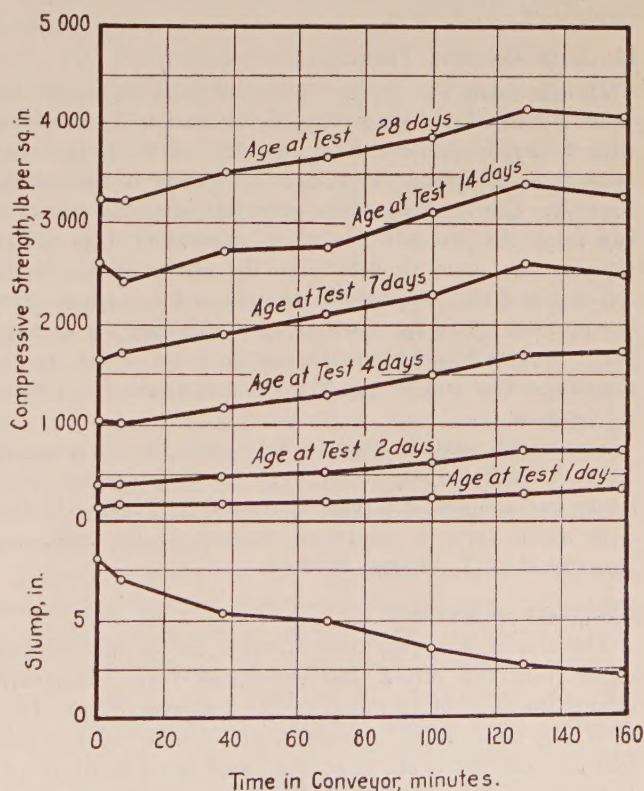
General Features of the Test

Every reasonable precaution was taken to control ac-

curately the quantities of all the materials going into the conveyor.

The operations with the concrete conveyor took place on December 29 and 31, 1930, in five separate runs designated hereafter as Series A, B, C, D and E, in the order named. The average and minimum temperatures for the working hours on these days were: December 29, average temperature 30 deg. F., minimum 26 deg. F. at 8 a. m.; December 31, average temperature 28 deg. F., minimum 22 deg. F. at 8 a. m. Each of the first four series consisted of charging the conveyor with two cubic yards of concrete, driving the conveyor around the streets for about $2\frac{1}{2}$ hours and taking samples at intervals of about $\frac{1}{2}$ hour.

Series E differed from the rest in that the conveyor was driven around with its charge of concrete for only 1 hour and 15 minutes instead of $2\frac{1}{2}$ hours and in that no samples were taken, either for determining the composition of



Average slumps and compressive strengths of samples in Series A, B, C and D

Condensed from paper presented before 34th annual meeting of the American Society for Testing Materials, Chicago, Ill., June 22-26, 1931.

the concrete or its strength. It was used principally for inspecting the appearance of the concrete in the drum and during its discharge. An additional test was made in which, for comparison, samples of concrete were taken at intervals from a batch which was mixed in one of the Jaeger mixers used throughout the test.

Description of Conveyor

The conveyor consists of a truck upon which is mounted a cylindrical drum container of a rated capacity of 2 cu. yd., into which the concrete is placed through an opening in the surface of the cylinder, about midway of its length. This opening is provided with a watertight door sealed by a rubber gasket, occupying a groove in the lip of the opening. No leakage was observed during the rotation of the drum.

The drum is smooth on the interior and depends entirely upon friction of the concrete on the surface for any mixing action which may take place. The conveyor is not intended primarily as a mixer, but it is expected to provide enough agitation to prevent segregation of the concrete during transportation. During transportation the drum is rotated at about 8 r.p.m. by a mechanism with which the drum may be rotated independently of movements of the truck.

Conduct of Tests

Two small Jaeger mixers were used for mixing the concrete. Eight batches, four in each mixer, were used for each charge of two cubic yards. The cement and aggregates were used in the proportions of 1:2.33:4.15 by weight. Seven gallons of water per bag of cement were used, and the absorbed and surface moisture were included as part of the seven gallons. The concrete was mixed $1\frac{1}{2}$ minutes and as it came from the mixer the slump was about 8 in.

Methods Used in Testing

The conveyor was charged with two cubic yards of concrete, for which the quantities of the various constituents were definitely known. Samples were taken of the concrete as it came from the mixer just before it entered the conveyor, and at various time intervals after the conveyor had been charged and placed in operation. One set of samples was used to determine the slump of the fresh concrete and the compressive strength of the concrete after having been cured for various ages. Another set of samples was used to determine the composition of the freshly mixed concrete and thus to discover any tendencies toward segregation.

From each sample used to determine the compressive strength, three slump tests were made promptly after taking the samples, and then eighteen 6 by 12-in. cylinders were made, three to be tested at each of the following ages: 1, 2, 4, 7, 14, and 28 days.

Summary of Results

The slump was generally about 8 in. as the concrete came from the mixer, but decreased very consistently during the time of retention in the conveyor drum. Even after $2\frac{1}{2}$ hours in the conveyor, the consistency was such that the concrete could have been used quite satisfactorily for road or pavement work, where the requirements are especially rigid.

The amount of water and the sum of the absolute vol-

umes of the cement and aggregates remained practically constant throughout each run. The amount of cement, however, appeared to increase. As this apparent increase was about the same as the decrease in the absolute volume of the sand, it is likely that it was due to the pulverizing of the aggregates, especially the sand.

The apparent increase in cement content in a batch of concrete mixed in a Jaeger mixer for 1 hour and 15 minutes was much greater than that in the drum of the conveyor, and the stiffening of the batch was correspondingly more marked.

No Segregation

There was no indication of segregation of the concrete in the conveyor drum as observed visually, or as determined by testing the composition of the concrete.

The strength of the concrete from samples taken at successive intervals after charging the conveyor drum increased progressively according to the length of time of transportation.

The difference between the lengths of time of initial set of the two cements used had no effect on the results, so far as such effects could be observed or measured in a test of this sort.

Road Builders Announce Plans for 1932 Gathering

Meetings scheduled for the 1932 American Road Builders Association annual convention at Detroit, January 9 to 15, will be held in the same building as the machinery exhibit. Both activities will be housed completely in the Municipal Airport Building, 1000 ft. long by 200 ft. wide, and an annex 400 by 100 ft.

Distributors' day will be held January 9. Registration and convention and road show opening will take place January 11.

Half of the general session on Tuesday, January 12, will be devoted to concrete. Subjects scheduled on the tentative program for that time are Recent Practical Developments in Design and Construction of Concrete Highways, Recent Practical Developments in Design and Construction of Reinforced Concrete Pavements and Bases, and, Bins, Batchers, and Equipment for Handling and Weighing Bulk Cement.

In the Technical Society Journals

Recent Developments in Light-Weight Floor and Roof Construction. A 30-page paper on this important subject, by Burtis S. Brown, consulting engineer, Boston, Mass., appears in the June (1931) *Journal* of the Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

The author discusses the economics of light-weight floor construction, the importance of maintaining the qualities of rigidity and fireproofness, and the necessity of combining these qualities with reduced dead weight.

The advantages, disadvantages and limitations of various types of floor construction are stated. The light-weight floor materials and methods of construction described include haydite and other light-weight aggregates, aerocrete and porete.

Proportions for Concrete Computed From Data on Aggregates

Formula Gives Close Approximation to Ideal Proportions After Aggregates Are Analyzed—Example Illustrates Method of Procedure

By ARCHIE A. SMITH
Concrete Engineer, San Bernardino, Calif.

Some thoughts are given here on concrete proportioning, in which nothing new is presented, except possibly a certain employment of well known facts and principles.

It is assumed that the water-cement ratio law is fundamentally sound and correct and is the principle upon which concrete proportioning should be based; and that its application in the making of concrete of predicted properties, for given materials and conditions of mixing, placing and curing, depends upon the condition that the quantity of cement paste is sufficient to coat all of the aggregate particles and to fill the voids in the aggregate; meaning that the aggregate particles must be individually floated or suspended in the cement paste and completely surrounded by it. This condition is next in importance to the water-cement ratio law itself. Fresh mortar and concrete fulfilling this condition will be described as dense and plastic throughout this statement.—The Author.

TO produce a dense and plastic mortar, using a given sand, the quantity of cement paste necessary is plainly a function of the total surface area of the sand grains and the voids in the sand. Similarly, to produce a dense and plastic concrete, using a given coarse aggregate, the quantity of mortar necessary depends upon the total surface area of the coarse aggregate pieces and the volume of voids they contain.

The least cement and sand proportions that will produce concrete which will develop design values are such that the cement paste in the mortar and the mortar in the concrete are the quantities that will just satisfy the conditions for dense, plastic concrete, as stated above. Less cement will cause porous mortar. Less sand, without increase of cement, will cause honeycombed concrete.

What Constitutes Correct Proportioning

It follows that, for given placing conditions, design values and aggregate, there are exact economic proportions. Deviation from these proportions immediately

affects the concrete, in one direction impairing its properties of strength, watertightness and bond, by producing harsh mixtures and honeycombed concrete, for which the water-cement ratio law does not hold; and in the other direction, causing excessive shrinkage and increased cost by increasing the cement content beyond actual requirements.

When, however, because of placing conditions, concrete designed to develop desired properties is difficult to place or finish, and adjustments of proportions are found necessary, they should consist in varying the cement paste content or mortar content or both; but not in a change of the water-cement ratio of the cement paste by adding water alone, or the sand-paste ratio of the mortar by adding sand alone. This statement does not apply to mass concrete designed principally or wholly to provide bulk or weight.

A Method of Procedure

An illustrative example is given here of a method of determining the proportions of cement and given aggregates, with the water-cement ratio law as its basis.

The volume of voids in a quantity of given aggregate can be readily determined by the well known unit weight-specific gravity calculation; but unfortunately, owing to their irregular form, the total surface area of the grains or pieces of aggregate can be determined only approximately. In the calculations that follow the particles are considered as spheres.

The quantity of paste necessary to coat a sphere to assumed thickness is less than that required to coat an irregular form of equal volume. However, the consideration of the particles as spheres, while not accurate, affords a general method of taking into account the total surface area, which is a function of the grading of the aggregate and one of the two factors determining the quantity of cement paste necessary for the mortar, and the mortar necessary for the concrete.

Correction factors or coefficients of form for different types of aggregate, as water-worn and crushed, expressing the relation of the surface area of actual to that of spherical form, in terms of the properties of fresh or hardened concrete, can be developed by laboratory tests and research. As the grading improves and the voids decrease the surface area increases and the importance of determining the quantity of paste and mortar required for coating becomes greater. Corrections may be applied as increases of surface area or of coating thickness. More

involved data than the above have been developed and are in use.

The Proportioning Formula

The following notation will be used:

(All volumes stated in cu. ft.)

W = volume of effective mixing water per sack of cement.

C = apparent vol. of 1 sack of cement, taken as 1 cu. ft.

Ca = absolute vol. of 1 sack of cement = 0.49 cu. ft.

W
— = water cement ratio selected for desired properties of concrete.

$P = W + Ca$ = volumetric yield of cement paste of 1 sack of cement.

Pv = volume of cement paste required to fill voids in 1 cu. ft. of dry rodded sand.

Pc = volume of cement paste required to coat the grains in 1 cu. ft. of dry rodded sand.

$Pv + Pc$ = volume of cement paste required for 1 cu. ft. of dry, rodded sand to produce dense, plastic mortar.

$\frac{P}{Pv + Pc}$ = Af = volumetric proportion of dry, rodded sand required for 1 sack of cement to produce dense, plastic mortar.

Afa = absolute vol. of Af .

$M = Afa + P$ = dense, plastic mortar yield of 1 sack of cement.

Mv = volume of mortar required to fill voids in 1 cu. ft. of dry, rodded coarse aggregate.

Mc = volume of mortar required to coat the pieces in 1 cu. ft. of dry, rodded coarse aggregate.

M
— = Ac = volumetric proportion of dry, rodded coarse aggregate required for 1 sack of cement to produce dense, plastic concrete.

Aca = absolute vol. of Ac .

Volumetric proportions of mixture = $C:Af:Ac$.

Volume of fresh concrete = $W + Ca + Afa + Aca$ (entrapped air voids neglected).

An Illustrative Example

The example that follows will illustrate the application of the method of procedure just discussed:

Weight of water is taken as 62.5 lb. per cu. ft.

$\frac{W}{C}$
Selected — = 1 = 7.5 gal. of water per sack of cement.

Specific gravity of aggregate is taken as 2.65.

Weight of sand loose, damp, 91.5 lb. per cu. ft.

91.5 lb. loose, damp = 88.3 dry.

1 cu. ft. dry, rodded, weighs 109 lb.

Weight of loose, damp, coarse aggregate = 98 lb. per cu. ft.

98 lb. loose, damp = 96 lb. dry.

1 cu. ft. dry, rodded, weighs 103 lb.

SIEVE ANALYSIS

Aggregates	Sieves									
	100	50	30	16	8	4	3/8	3/4	1 1/2	
Sand	97	78	57	30	18	0	0	0	0	0
Coarse aggregate	100	100	100	100	100	97	68	32	3	

Values and quantities used in computing the surface area of these aggregates are taken from Table 1, which has been worked out on the basis of considering the aggregate particles as spheres.

Surface Area of Sand

Approximate surface area of sand particles are calculated from the sieve analysis by considering the groups or percentages passed and retained by successive sieve sizes, as shown in Table 2.

TABLE 1
Surface Area of Aggregate, Particles Considered as Spheres

Sieve size or number.	Clear opening in inches.	Average size or diameter of particles passed and retained by successive sieve sizes.	Surface area per gram, in sq. in.	Surface area per pound, in sq. in.	Surface area per 100 lb., in sq. in.
100	0.0059	0.0044	32	14,500	1,450,000
		0.0088	16	7,260	726,000
50	0.0117				
		0.0176	8	3,625	362,500
30	0.0232				
		0.0351	4	1,815	181,500
16	0.0469				
		0.0702	2	908	90,800
8	0.0937				
		0.1404	1	454	45,400
4	0.187				
		0.2810	0.5	227	22,700
3/8	0.375				
		0.5625	0.25	113.5	11,350
3/4	0.75				
		1.125	0.123	55.8	5,580
1 1/2	1.50				
		1.75	0.08	36.3	3,630
2	2.0				

TABLE 2
Surface Area of Sand

	Per-centage passed & No. retained	Unit wt. 1 cu. ft. lbs.	Wt. of each size group, lbs.	Surface area per lb. in sq. in.	Total surface area of each size group, in sq. in.
Passed	4				
Retained	8	.18 ×	109 =	19.6	454
Passed	8				8,840
Retained	16	.12 ×	109 =	13.1	908
Passed	16				11,880
Retained	30	.27 ×	109 =	29.41	1,816
Passed	30				53,500
Retained	50	.21 ×	109 =	22.89	3,630
Passed	50				83,100
Retained	100	.19 ×	109 =	20.87	7,260
Passed	100	.03 ×	109 =	3.27	14,500

Approx. surface area of particles in 1 cu. ft. dry, rodded sand = 355,220 sq. in.
Thickness of cement paste coating on sand particles is taken as 0.0022 in.

$$P_v = 1.00 - \frac{109}{2.65 \times 62.5} = 0.34 \text{ cu. ft.}$$
$$P_c = \frac{.0022 \times 355000}{1728} = .45$$
$$P = W + Ca = 1 + 0.49 = 1.49 \text{ cu. ft. of cement paste from 1 sack of cement.}$$
$$A_f = \frac{P}{P_v + P_c} = \frac{1.49}{0.34 + 0.45} = 1.89 \text{ cu. ft. of dry, rodded sand per sack of cement.}$$
$$\frac{109}{88.3} \times 1.89 = 2.33 \text{ cu. ft. of loose, damp sand per sack of cement.}$$

The absolute volume of 1 cu. ft. of dry, rodded sand = $\frac{109}{2.65 \times 62.5} = 0.66$

Then $Afa = 1.89 \times .66 = 1.25 \text{ cu. ft.}$

$M = Afa + P = 1.25 + 1.49 = 2.74 \text{ cu. ft.} = \text{dense, plastic mortar yield of one sack of cement.}$

TABLE 3
Surface Area of Coarse Aggregate

	Per-centage passed & In. retained	Unit wt. 1 cu. ft. in lbs.	Wt. of each size group, in lbs.	Surface area per lb. in sq. in.	Total surface area of each size group, in sq. in.
Passed	2				
Retained	1.50	.03 ×	103 =	3.09	36.3
Passed	1.50				112
Retained	0.75	.29 ×	103 =	29.87	55.8
Passed	0.75				1,670
Retained	3/8	.36 ×	103 =	37.10	113.5
Passed	3/8				4,210
Retained	3/4	.29 ×	103 =	29.87	227.0
Passed	3/4				6,800
Retained	4	.03 ×	103 =	3.09	454.0
Passed	4				1,403

Approx. total surface area of pieces in 1 cu. ft. dry, rodded coarse aggregate..... 14,195 sq. in.

Surface Area of Coarse Aggregate

Approximate surface area of pieces in 1 cu. ft. of dry, rodded coarse aggregate, are obtained in the same manner as for sand, and as shown in Table 3.

Per cent of fine aggregate	Ave. size or dia. of grains in groups passed and retained by successive sieves, inches	
18	×	.1404 = 2.53
12	×	.0702 = 0.843
27	×	.0351 = 0.947
21	×	.0176 = 0.37
19	×	.0088 = 0.167
3	×	.0044 = 0.0132

Weighted size or diameter of sand grains = $4.8602 \div 100 = .0486 \text{ in.}$
 $(.0486 \div 2) + .0032 = .0275 = \text{thickness of mortar coating on coarse aggregate pieces.}$

The corrections referred to before are assembled in one factor, selected semi-arbitrarily as 1.24 and applied in determining Mc in

$$Mc = \frac{.0275 \times 14200 \times 1.24}{1728} = 0.28 \text{ cu. ft.}$$
$$Mv = 1.00 - \frac{103}{2.65 \times 62.5} = 0.38 \text{ cu. ft.}$$
$$Ac = \frac{M}{Mc + Mv} = \frac{2.74}{.28 + .38} = 4.15 \text{ cu. ft. of dry, rodded coarse aggregate.}$$
$$\frac{103}{96} \times 4.15 = 4.45 \text{ cu. ft. of loose, damp coarse aggregate.}$$

The volumetric proportions then are:
For dry, rodded aggregate 1 : 1.89 : 4.15.
For loose, damp aggregate 1 : 2.33 : 4.45.
The usual correction for water carried by the aggregate is omitted here.
This method of mixture design is applicable to the determination of proportions of coarse aggregates of two or more size divisions or ranges.

Engineers' Report on Aerocrete Floors to Come Later

Tests of aerocrete floor construction, conducted in Chicago early this year under the supervision of an official committee of engineers representing the city of Chicago, were described in the July and August issues of "Concrete."

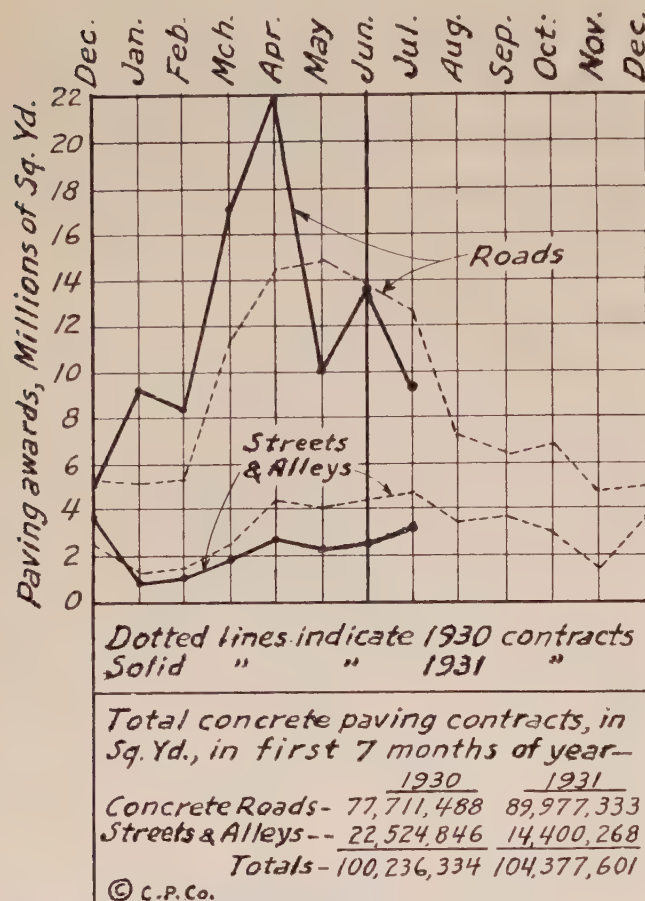
The committee of engineers is now engaged in completing its report, containing its conclusions and recommendations. On the basis of the committee's recommendations, official regulations are to be prepared by the city to govern the design and construction of this type of floor.

When the committee's report is completed, an abstract of its recommendations will be published in "Concrete," as the final installment of this interesting series.

Concrete Road Contracts Lead 1930 by 12 Million Yards

Street Paving 8 Million Sq. Yd. Below Last Year—Shows Slight Pick-Up

The month of July is the third consecutive month in which contracts awarded for concrete highway work fell below the figures for 1930, although the total for the first 7 months of 1931 still leads the corresponding period of last year by 12,265,845 sq. yd., according to reports received by the Portland Cement Association.



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Part of the falling off in contracts is due to work being held up in Illinois because of disputes over interpretation of the prevailing wage scale law enacted by the last legislature. However, it is probable that, considering the entire country, the balance of the year will make a favorable comparison with last year.

Concrete street paving awards continue below last year, but there was a distinct pick-up in July. Time alone will tell whether deferred street paving work is beginning to be placed under contract.

The total paving contracts reported for July are as follows, expressed in sq. yd.:

	1930	1931
Concrete roads	12,719,601	9,309,083
Streets and alleys.....	4,696,060	3,160,483
Totals	17,415,661	12,469,571

Study Commercial Curing Methods for Concrete Pavements

Highway Research Board Results of Two-Year Investigation—Advantages of Newer Methods

By R. W. CRUM

Director, Highway Research Board, Washington, D. C.

In these days the construction of a concrete pavement moves ahead so rapidly, and so much more is put down in a day or a week than was the case just a short time ago, that the problem of securing adequate curing of the concrete has taken on new aspects. Although most highway engineers still think that the most favorable curing condition exists when the slab is kept damp during the curing period by means of a wet covering of earth, sand, hay or straw, sometimes practical difficulties arise that make other methods appear attractive. Difficulty in providing an adequate water supply for keeping some two miles of cover properly wet; difficulty in securing thorough compliance with the specifications so far behind the crew; and lack of opportunity to inspect the finished work, are some of the factors that have opened the way to the use of other methods.

Study of Curing Methods

For two years a special committee of the Highway Research Board has been studying "Curing" and gathering facts concerning the more extensively used methods. A review of the available data is presented in the progress report of this committee in the Tenth Annual Proceedings of the board.

Although research studies have not yet progressed to a point where definite standards of comparison for different curing methods can be set up, considerable information is available on strength, surface condition and volume change, all of which give some indication of curing qualities.

Surface Application of Calcium Chloride

Surface applications of calcium chloride in regions where the air temperature and humidity are such that the salt will readily dissolve have been found to produce concrete 90 per cent or more as strong as concrete cured with a wet cover, with no greater changes in volume. This method has not been found to be a primary cause of surface scaling in appreciable amounts. Extensive surveys show that the percentage of total area scale under either wet earth or calcium chloride surface curing is very small.

Bituminous Coatings

Concrete cured with bituminous coatings, in general, showed strength 90 per cent or more of that of wet cured concrete. Volume changes, as evidenced by temperature ranges, direct measurement and crack surveys, are greater, indicating that more frequent shrinkage cracks are to be expected unless prevented by proper joint spacing. Bituminous-cured pavements in regions where fine sand subgrades are a distinctive feature have been examined which showed uncracked slab lengths as great or greater than those on pavements cured with wet earth. Coating the bituminous-covered surface as soon as possible with some light colored material such as whitewash appears to decrease the volume changes.

Estimating Cost of Concrete Work

Many Items Included in Plant Cost—Making Proper Equipment Charges—Cold Weather Expense Itemized—Average Insurance Costs in Several States

IV—Concreting Plant; Cold Weather Expense; Insurance

By LESLIE H. ALLEN
Aberthaw Company, Boston, Mass.

IN addition to the items of concrete construction work on which estimates and estimating methods have been given in previous articles in this series, the present article covers three items which are often underestimated.

CONCRETING PLANT

The cost of the contractor's plant for a concrete job is a considerable item. It is usually underestimated by contractors, and unless very careful records are kept the loss of small tools, and of repairs and depreciation of large plant items like mixers, hoists and motors, the loss of plant items may run on for a year or more before the need for renewal brings them to the contractor's attention.

Proper Charges for Wear of Equipment

The business-like contractor keeps a separate account for his plant, and charges each mixer, hoist, and similar items, to each job at a weekly rental that is sufficient to cover repairs and amortization; or else he will charge the entire cost of each item to the job and credit the job with its salvage value when the building is completed.

The cost of trucking or freight on plant to and from a job must be figured, and also the labor cost of erecting and dismantling the plant.

Plant estimates will also include costs of shovels, picks and other small tools furnished to the job, most of which will be worn out before the contract is completed. The use of barrows and buggies, the cost of power, fuel and oil, rubber boots, foremen's office, workmen's shanties, and all such items, must not be overlooked.

Estimate of Plant Cost

A typical estimate for plant on a concrete 4-story building 50x200 ft., containing 2,500 cu. yd. of concrete, is given in the opposite column.

COLD WEATHER EXPENSE

On jobs that are built in cold winter weather, some money has to be spent in guarding against the effects of frost and in removing snow and ice. Aggregates and water have to be warmed, canvases installed and salamanders kept burning.

As no one can foretell just what weather conditions will be encountered on a future job, the most careful estimate of cold weather expense is likely to prove much too high or too low. No exact method of figuring can be prescribed.

The following estimate of cold weather expense on a Boston job, 50 by 200 ft., 4 stories high, built in Decem-

ber, January and February, is an example of the way this problem should be studied.

The quantity of concrete placed on this work was 2,500 cu. yd., so that the unit cost of protection against cold weather was \$1.40 per cu. yd.

INSURANCE

The estimate of cost of concrete work should include the cost of insurance for workmen's compensation, public liability, fire, tornado, payroll robbery and other items. The largest of these items is the first named. The rates vary with the different trades employed and are based on different manual rates in every state.

If the contractor does not accurately subdivide his payroll according to trades, he will be charged an average figure that is higher than what he would have to pay if he kept his time properly divided.

The average cost of all the above items of insurance on a typical concrete job in Massachusetts is 5 per cent on the payroll at the present time; in Connecticut it is 4½ per cent; in New York, 6½ per cent.

If the contractor uses proper care in installing safety devices and is watchful to prevent accidents, recognition will be given to his low accident record by the insurance

ESTIMATED COST OF CONCRETING PLANT

Mixer and motor, rented 14 weeks @ \$35	\$490
Electric hoist, rental 14 weeks @ \$30	420
Level or transit, rental 14 weeks @ \$3	42
Lumber for wood tower 60 ft. high, 2 M @ \$40	80
Bolts and guys for tower	40
Concrete bucket, rental 14 weeks @ \$4	56
Boom on tower for hoisting steel, rental 12 weeks @ \$2	24
Small tools and barrows, buggies, etc.—\$900 less probable salvage of \$300	600
Oil and waste, rope and sundries	250
Lumber for runways and miscellaneous uses	250
Power and water	300
Trucking to and from the job	100
Temporary buildings (office, shanties, latrines, etc.), labor	300
Temporary buildings, lumber, etc.	250
Telephone	100
Labor erecting mixer	150
Labor erecting wood tower and hoist	200
Labor dismantling plant	150
Total	\$3,802

ESTIMATED COLD WEATHER EXPENSE

Rental of 50-hp. boiler for heating aggregates, 12 weeks @ \$20.....	\$240
Erection of boiler, labor.....	100
Erection of boiler, piping and valves.....	75
Erection of boiler, housing and shanty (lumber and labor).....	100
Coal for boiler, 1 ton per day for 50 days—50 tons @ \$8.....	400
Stoking usually done by hoisting operator during the day and by the night watchman at night, their time being charged to other operations.....	
Labor, shoveling snow and removing ice.....	400
Salamanders, one per 200 sq. ft. over half area of one floor = 25 salamanders @ \$8.....	\$200
Less probable salvage value.....	75
	125
Coke for salamanders, 125 lb. per salamander per day, estimated 35 days actual use, $25 \times 35 \times 125$ lb. = 55 tons @ \$11.....	605
Labor tending salamanders, one day man and one night man = 2 men 35 days = 70 days @ \$7.....	490
Canvas sufficient to enclose one floor, 30 canvases @ \$40.....	\$1,200
Probable salvage value.....	600
	600
Labor, erecting and removing canvas 5 times each—150 times @ \$2.50.....	375
Total estimate of cold weather expense.....	\$3,510

companies, who will allow him an "experience rating" or discount on the manual rates.

CONCLUSION

In conclusion, let it be repeated that this series of articles on "Estimating Cost of Concrete Work" is not an infallible handbook of cost data. It is written to help the young estimator to plan his work wisely and to think logically about the cost of his work.

Prices of labor and materials can not be learned from a textbook, for no two contractors will get identical costs on similar pieces of work done under similar conditions.

The only good cost data for the estimator are those compiled by his own firm; they reflect the abilities and shortcomings of its management; they will give him an advantage on certain types of work and place him at a disadvantage on others.

But it is worse than useless to use a low unit cost on an estimate for a large piece of work (form work, for example) simply because he knows other contractors will use it. If his firm's records show that they have not been able to build form work for low costs he is only asking for trouble and inviting loss by estimating lower units than those he knows his firm can secure on the job.

The primary purpose of estimating is not to obtain a contract, but to obtain a profitable contract. If these notes are of any help to the young contractor in attaining this goal, and in eliminating from his records the sad experience of jobs badly priced, showing large red ink figures at their conclusion, the time spent on compiling these articles will be well repaid.

California A. C. P. M. Developing Standards for Pipe

The annual meeting of the California Associated Concrete Pipe Manufacturers will be held in Fresno, September 4 and 5, with an evening meeting of committee chairmen and directors on Thursday, September 3. The place of meeting will be at the Hotel Californian.

Interesting matters are to be taken up at this session. Effort will be made to work out a national standard specification for concrete irrigation pipe, and also standardized bulletins and literature.

The committee on standardized laying practice is to report its findings and recommendations and it is hoped that the association will be able at this session to work out some standard practice and literature on this subject.

PERSONALS

Roy L. Peck has resigned his position with the Chicago office of the Pittsburgh Testing Laboratories to join the haydite division of the Western Brick Company, of Danville, Ill. He was formerly connected with the service department of the Marquette Cement Manufacturing Company.

D. D. McGuire has resigned as district engineer in charge of the St. Louis office of the National Sand and Gravel Association, to accept appointment as assistant to the president, Standard Building Materials Co., of St. Louis.

Mr. McGuire was formerly engineer of tests for the Tennessee State Highway Department.

Coming Conventions

September 6-12—New International Association for Testing Materials, First International Congress. Swiss Federal Polytechnicum, Zurich, Switzerland.

September 28-30—Concrete Reinforcing Steel Institute, semi-annual meeting. Buckwood Inn, Shawnee-on-Delaware, Pa.

October 5-10—Pacific Coast Building Officials' Conference, tenth annual meeting. Berkeley, Calif.

October 12-16—National Safety Council, 20th Annual Safety Congress and Exposition. Chicago, Illinois.

January 9-15—American Road Builders Association, twenty-ninth annual convention and road show. Municipal Airport Building, Detroit, Mich.

January 25-26—National Ready-Mixed Concrete Association, second annual convention, William Penn Hotel, Pittsburgh, Pa.

January 27-29—National Sand and Gravel Association, sixteenth annual convention, William Penn Hotel, Pittsburgh, Pa.

Cutting Corners in Concrete Structural Design

Parker Marked Slide-Rule Method Designs Concrete Beams and Slabs Without Use of Charts or Tables—
Illustrative Examples

I—Slide-Rule Method of Design

By J. R. GOETZ
Structural Engineer, Chicago, Ill.

In this first installment of this new series of articles on time-saving devices for the use of structural designers the author presents a unique method for the employment of the slide-rule in the routine structural design of reinforced concrete beams and slabs.

This method, devised by L. G. Parker, is here presented in published form for the first time.

The outline of this series of articles appears on page 31 of the July issue of "Concrete."—The Editors.

STRUCTURAL engineers engaged in designing concrete buildings are constantly confronted with the necessity for more speed in the computation of ordinary slabs and beams, in order that more time and thought may be given to the more complicated parts of the structure. To accomplish this result, a multitude of tables and diagrams have been brought out from time to time, each designer having some favorite method of his own.

After trying out and rejecting several short-cuts, the writer was introduced to the "marked slide-rule" method, one which is very rapid and which requires no written computations, tables or diagrams for the solution of slabs and simple beams with balanced reinforcing. This method was developed several years ago by L. G. Parker, formerly chief structural engineer for Marshall & Fox, architects, of Chicago. Owing to the fact that it has never been published, the Parker method has never come into as wide use as its merits deserve. It is with Mr. Parker's permission that this article is written.

Slabs

First let us consider the design of slabs, assuming in all cases a width of 12 in., unit stresses in concrete and steel as fixed either by the existing building code or the choice of the designer, and bending moments expressed in foot-pounds.

Then, as M in ft.-lb. = $\frac{f_c k j b d^2}{2 \times 12}$ and $b = 12$ in., we have

the relation,

$$d = \sqrt{\frac{2}{f_c k j}} \times \sqrt{M}, \text{ or, letting the constant } \sqrt{\frac{2}{f_c k j}} = d_1,$$

the equation reduces to $d = d_1 \sqrt{M}$.

For the amount of reinforcing steel necessary to develop this bending moment at the depth found, we have

$$\text{the familiar equation } A_s = \frac{12M}{f_s j d}.$$

Substituting the value of

d , as given above, we have,

$$A_s = \frac{12}{f_s j \sqrt{\frac{2}{f_c k j}}} \times \sqrt{M}, \text{ or letting the constant } \frac{12}{f_s j \sqrt{\frac{2}{f_c k j}}} = A_1,$$

the equation becomes $A_s = A_1 \sqrt{M}$.

Table of Constants

Here, then, are two expressions involving the effective depth, in inches, and the area of steel required, in square inches, together with the square root of the bending moment in foot-pounds. Following is a table giving these and other useful constants for various combinations of unit stresses.

TABLE 1
Flexural Properties of Concrete

f_s	f_c	k	J	$\frac{K}{M^{1/2}}$	d_1	A_1
16000	650	.379	.874	8.96	.0965	.00890
"	700	.396	.868	10.05	.0912	.00946
"	750	.413	.862	11.12	.0865	.01006
"	800	.429	.857	12.22	.0825	.01060
18000	700	.368	.877	9.45	.0940	.00808
"	750	.385	.872	10.47	.0891	.00858
"	800	.400	.867	11.55	.0850	.00905
"	850	.415	.862	12.65	.0811	.00954
20000	700	.344	.885	8.89	.0970	.00698
"	750	.360	.880	9.89	.0919	.00743
"	800	.375	.875	10.94	.0873	.00786
"	850	.389	.870	12.00	.0835	.00826
"	900	.403	.866	13.10	.0798	.00868

For the purposes of illustration, let us assume the following constants: $f_s = 20,000$ lb. per sq. in., $f_c = 300$ lbs. per sq. in., and $n = 15$. Then from the table, $d_1 = .0873$ and $A_1 = .00786$.

Set the indicator glass of the slide-rule so that the hairline is over the number 8 on the A scale. With a writing pen and India ink, make a short line on the glass opposite the right-hand index on the B scale. Mark this " M ". Opposite the number 873 on the D scale, make another line on the glass and mark it " d ". Opposite the number 786 on the C scale make a third line on the glass marked " A_s ". The face of the indicator glass should now look like Figure 1.

Now if the mark " M " is set opposite any bending moment on scale B (with due regard to the decimal point), the mark " d " will fall opposite the effective depth, in inches, on scale D , and the mark " A_s " will be found opposite the area of reinforcing steel, in square inches, on the C scale. For example, if $M = 6,000$ ft.-lbs., $d =$

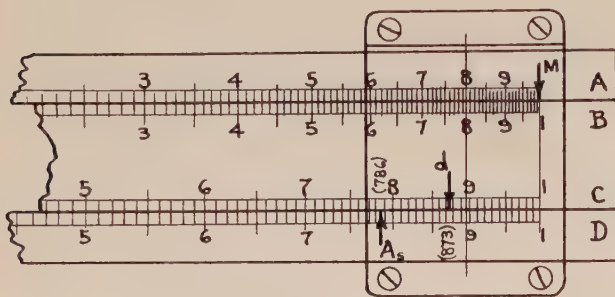


Figure 1

6.75 in., and $A_s = 0.61$ sq. in. (per foot width of slab). Observe that the regular hairline on the indicator glass

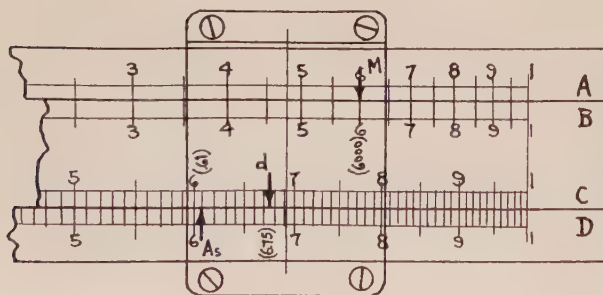


Figure 2

has not been used. This example is illustrated by Figure 2.

Beams

Let us now take up the design of beams of any width, other than 12 inches.

Set the slide so that the width of beam, in feet, on the B scale, is opposite the index M on the A scale (see Figure 3). With the rule left in this position, move the indicator glass so that the mark " M " is opposite the bending moment on the B scale. Then opposite mark " d ", on the D scale, read off the required depth of beam, in inches.

Now move the indicator glass so that the mark " M " is directly over the bending moment on the A scale, and

opposite mark " A_s " read the required area of steel, on the C scale. For example, if $M = 78,000$ ft.-lb. and $b = 17$ in., then $d = 20.5$ in. (see Figure 3), and $A_s = 2.61$ sq. in. (see Figure 4).

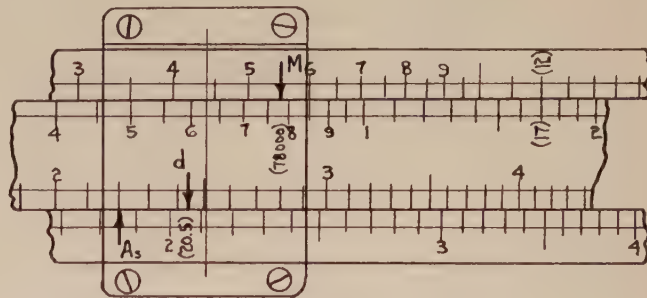


Figure 3

By a reversal of the above process, the required breadth of a beam (in feet) is found if the depth and bending moment are known, or the greatest allowable bending moment may be found if the breadth and depth of the beam are known. For any change in the values of f_s and f_c , new marks must be made on the indicator glass, but if

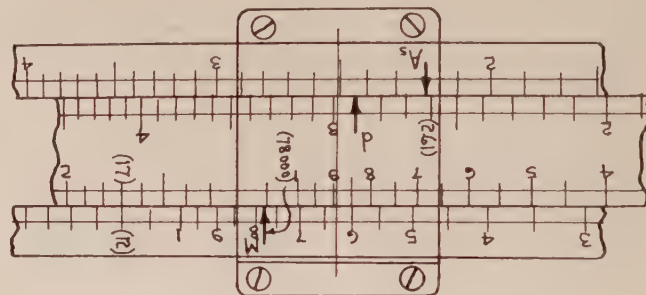


Figure 4

the same values are used continually the marks may be scratched on the glass with a needle. This should preferably be done on the under side, to avoid parallax.

The position of the hairline at number 8 was selected for two reasons. In the first place, if this number is used, the marks for a number of values of f_s and f_c will be found to fall on the glass. Also, in a great number of instances, beams are to be designed as simply supported, with a uniform load covering the entire beam. In other

words, the expression for bending moment is $M = \frac{wl^2}{8}$.

Now if the index of the slide-rule is placed opposite the unit load w , on the A scale, and the hairline of the indicator is placed opposite the span in feet l , on the C scale, the mark " M " will be found to be directly over the bending moment in foot-pounds on the A scale, and the rule is thus set at once for reading depth and steel. This eliminates one extra operation on the rule for this particular kind of beam or slab.

With a small amount of practice, the designer will find considerable time saved by the use of the method here described.

Other subjects to be covered in the immediate future by this series are the use of compression steel in concrete beams and over-reinforced beams and slabs.

EDITORIAL

Where Laboratories and Construction Practice Disagree

PROBABLY in no field of laboratory research dealing with cement and concrete do laboratory results differ so widely from actual construction results as in the reported effects of admixtures in concrete.

In laboratory reports one frequently encounters a statement to the general effect that "admixtures weaken concrete except in the case of lean or improperly proportioned mixtures."

The statement just quoted is completely at variance with results reported on actual construction work. To cite one example among many, in the first column on page 24 of the July (1931) issue of "Concrete" a construction superintendent reports a decided increase in 28-day strength (from 2,900 to 4,000 lb. per sq. in.) as the direct result of the use of a siliceous admixture.

Similarly, Cloyd M. Chapman, a well-known consulting engineer of New York and one of the most active workers in the A. S. T. M., has something of interest to say in his article "Can Admixtures Be Standardized?" in the June (1930) issue of "Concrete." In his concluding statement he says: "It is noticeable, as one goes about the country meeting men interested in concrete, how many of them tell of some experience involving the use of some fourth ingredient in concrete—something besides cement, water and aggregate—and the remarkable results they obtained."

There must be a reason for the disagreement between laboratory test results and construction results. Quite probably the disagreement arises from the fact that in this instance the very nature of the problem is such that the laboratory can not possibly duplicate actual conditions prevailing on construction work.

In the laboratory, for example, the mixing and placing of concrete is a simple, routine matter. On a large construction project the mixing, the transporting, especially, and the placing of concrete are major problems.

It is in connection with the transportation of concrete that the advantages of certain types of admixtures become most pronounced. An admixture may permit the concrete to be transported in chutes, for instance, without segregation of coarse particles, without loss of mortar, and so on. Such advantages have no opportunity to give evidence of themselves in laboratory concrete, where no transportation is required; and, in consequence, laboratory tests do not demonstrate those advantages.

The various general types of admixtures affect and improve concrete in different ways. Only when con-

crete is mixed, transported and placed under the adverse influence of construction job conditions do those improvements and advantages become evident.

Many Cities Need This Improvement

IN Muncie, Indiana, the local government is in the midst of a modest program of public improvement which may well provide an example to many other cities, large or small.

Fifty protruding street corners, originally laid out to 4-ft. or 6-ft. radius, are being cut back to a radius of 15 or 30 ft., greatly increasing the traffic capacity of corners and relieving congestion at these points. The cost of the work is small, considerably less than during busier seasons, for labor and material items are materially reduced.

While this work is being done largely as a means of providing employment, the work undertaken has long been needed. At a very moderate cost it adds appreciably to the capacity and the safety of the principal streets. At the same time it is providing work to local labor which otherwise would be idle.

Undoubtedly a widespread and rather forceful sentiment has developed against the construction of public improvements that involve increased taxation or special assessments. Here, on the contrary, is a type of useful improvement that does not call for increased taxation, for the city is paying for the work out of maintenance funds. The work utilizes both labor and material, thereby spreading its benefits in many directions.

Many cities have available funds in hand for the construction or maintenance of public improvements, which are lying idle because the work is not being pushed forward to the construction stage. It would be a blessing if the example of Muncie were followed everywhere.

One Way to Increase Road Funds

DURING 1930 the State of Iowa built more than a thousand miles of concrete roads. Contracts for more than five hundred miles were awarded in the first seven months of this year.

It is, therefore, not by accident that gasoline tax collections in Iowa during the first seven months of this year exceeded the collections in the corresponding part of 1930 by more than half a million dollars.

Increased concrete highway mileage means increased travel, and a corresponding increase in the gasoline tax collections returned to the highway construction fund, for the construction of more roads.

The moral is, push concrete highway construction to the limit of funds available.

PROGRESS—In a Page

◀ Current activities in research, in matters pertaining to concrete and cement, as being carried on or completed by various organized groups. ▶

Ready-Mixed Concrete Studied by Many Agencies

THE scientific study of ready-mixed concrete is going forward this year with renewed vigor, as is pointed out in a statement issued by the American Road Builders' Association.

An agreement as to a division of work was reached between committee chairmen representing several associations at a recent meeting in Chicago. This meeting was attended by the association representatives, who divided up the work as follows:

American Road Builders' Association—The study of equipment and construction methods for roads and streets;

American Concrete Institute—Uses other than roads and streets;

American Society for Testing Materials—Specifications for materials;

National Ready-Mixed Concrete Association—Utilization of data by the industry.

At a meeting of ready-mixed concrete machinery manufacturers, called by the American Road Builders' Association in Washington to discuss the work of the year, the scope of the studies was outlined. One of the principal studies will be a satisfactory means of depositing the product from the hauling unit to its proper place on the subgrade.

Important A. S. T. M. Publications Available Soon

A NUMBER of important publications are soon to be issued by the American Society for Testing Materials, as the following list indicates.

Year Book.—The 1931 Year Book, about 340 pages, containing the charter and by-laws, the list of members, geographical distribution of members, personnel of standing committees and list of standards and tentative standards, is now in course of preparation. This volume will be ready for distribution to all members about September 10.

1931 Supplement to the Book of Standards.—The first supplement to the 1930 Book of A.S.T.M. Standards, containing the 31 standards approved or revised at the recent annual meeting and now out to letter ballot for adoption, will comprise approximately 128 pages. It should be available for distribution about September 10.

Book of Tentative Standards.—The special volume containing all of the tentative standards of the society (169) in their latest revised form is now in preparation and will be available about October 15.

Combined Index of Standards.—A combined index of all standards and tentative standards of the society will again be issued complete with references to the publications in which the standards appear. This index should be available early in November and will be distributed to all members and others on request.

Five-Year Index to Proceedings.—In line with the so-

ciety's practice of issuing a collective Index to Proceedings at five-year intervals, work is now under way compiling the index of Volumes 26 to 30 inclusive. The index should be available about October 1.

Canadian Engineering Standards for Reinforcing Steel

THE Canadian Engineering Standards Association, 46 Elgin Street, Ottawa, Canada, has revised its specifications covering billet steel and rail steel reinforcing bars and steel wire for concrete reinforcement, and has issued these specifications in three separate volumes. Copies may be obtained from that association.

Course in Engineering Journalism at Iowa State College

JOURNALISM instruction at Iowa State College has been organized under the department of technical journalism. This department offers a four-year course in agricultural journalism, a major in journalism for students in home economics and a sequence of journalism subjects for students of industrial science.

It also has arrangements with the engineering college whereby a student enrolled in any engineering course—civil, electrical, chemical, mechanical—may elect a series of journalism subjects, substituting this journalism for certain engineering subjects.

In other words, an engineering student who is professionally interested in editorial or advertising work may arrange a course which combines engineering with journalism. He receives his degree, however, in engineering.

New Tentative Standards Approved by A. S. T. M.

THE following new specifications and methods of test, all of which were submitted by Committee C-9 of the American Society for Testing Materials, were approved as tentative standards during the recent annual meeting of that society:

Specifications for Curing Portland-Cement Concrete (C 80-31 T).

Specifications for Curing Portland-Cement Concrete Slabs with Bituminous Coverings (C 81-31 T).

Specifications for Curing Portland-Cement Concrete Slabs with Calcium Chloride Admixture (C 82-31 T).

Specifications for Curing Portland-Cement Concrete Slabs by Surface Application of Calcium Chloride (C 83-31 T).

Specifications for Curing Portland-Cement Concrete Slabs with Wet Coverings (C 84-31 T).

Method of Routine-Analysis of the Cement Content of Hardened Portland-Cement Concrete (C 85-31 T).

Method of Test for Apparent Specific Gravity of Coarse Aggregates in a Saturated Condition (C 86-31 T).

Method of Test for Structural Strength of Fine Aggregate Using Constant Water-Cement-Ratio Mortar (C 87-31 T).

Promote Concrete Paved Areas in Playgrounds

Newspaper Reader Points Out New Market for Concrete Work That Keeps Children Off the Streets—Concrete Construction in Many Forms

By CARL R. NELSON

Vice-President, C. L. Gungoll Company, Contractors, Chicago, Ill.

A NEWSPAPER reader, writing to the *Chicago Daily News*, expresses thoughts which apply with equal force to almost every community and which point out a market that concrete contractors can develop into new business. It is almost needless to say that my own company, which is actively engaged in the concrete contracting business, will follow out some of the suggestions made by this reader.

Keeping Children Off the Streets

With parents anxious to find safe playgrounds for their children, contractors are justified in following up the ideas expressed in this reader's comment. It appeared as follows under the heading, "For Children's Play," in the *Chicago Daily News* of March 16:

"Why would it not be well worth consideration to place concrete platforms, say in sizes anywhere from 50 feet by 100 feet and larger, in vacant lots and in playgrounds for the benefit of small children?

"I observed a few days ago some forty children, ranging in ages estimated at from 12 down to 5 years, playing in the street, some with tricycles, others with scooters and the greater number on roller skates. A large open vacant lot was within a few feet of these children. Not one of them was playing on it. If a large area of concrete had been there the street pavement would have had secondary consideration and, of course, the danger of the children being hit with automobiles would have been much less. The children want concrete for roller skating, cycling and marble playing, and the only place they can find it is in the streets."—C. W. B.

There are a great many districts which at present do not provide adequate parks or centers where children can play safe from traffic hazards. Other sections have playgrounds greatly in need of modernizing. Efforts should be made to interest communities in providing paved yards in existing play centers, and where no provision is at present made for play areas, sentiment should be developed to establish them, even though on a small scale.

Converting Small Areas into Playgrounds

In many sections where the community cannot afford full-sized play yards, ordinary vacant lots may be converted to such use, particularly for the smaller children of "coaster age."

School grounds also offer an excellent opportunity for the promotion of paved yards to provide a place for children to roller skate, cycle, and engage in other sports. Parents will be quick to endorse any move to replace with concrete the older cinder playground or school lot which results in such expensive wear and tear on shoes and clothing.

Promote Safety at Same Time

Promotion of these improvements can be tied in excellently with the nation-wide movement which is being



Concrete work in children's playground in Maywood, Illinois

supported by radio broadcasts and by the National Safety Council to keep children off the streets. American Legion posts and various civic and women's organizations in every community are actively identified with this safety movement, and through them interest can be developed to provide safer and more healthful recreational centers.

Experienced contractors are finding many ways to use concrete in parks and playgrounds to make attractive permanent improvements. They are building concrete tennis courts, swimming and wading pools, and other improvements which provide healthful recreation for everyone. Park benches, flagstone walks and handball, shuffleboard or roque courts are other community improvements that can be sold.

Contractors are pointing out to park boards and play-

ground and school officials that when concrete is used for these improvements, they are built to last and are maintenance-free. Whether the park, playground or school yard is large or small, concrete can be used to advantage in countless ways for improvements that are permanent and economical.

The letter in the *Daily News* shows that there is a demand for improvements of this kind. Contractors who go after this class of work will find that business is good.

Reinforcing Men Plan Conferences for Semi-Annual Meeting

A series of conferences dealing with reinforcing manufacturers' current problems is included in the tentative program of the Concrete Reinforcing Steel Institute semi-annual meeting September 28 to 30.

The steel men will meet at Buckwood Inn, Shawnee-on-Delaware, Pa.

Design and Spacing of Stirrups With Convenient Chart

Web Reinforcement in Reinforced Concrete Beams Determined and Located for Uniform and Concentrated Loading—Explanation of Chart

By ALBERT PERBAL

Perbal & Millstone, Structural Engineers, St. Louis, Mo.

THE writer has been experimenting for some time with tables and charts for the design of stirrups, in the hope of developing a table in which stirrups for beams may be designed as a group instead of individually, and with a minimum of slide rule work.

The chart presented with this article has been used for the past two years in the office of the writer and has proved a great time saver. This table is presented with the hope that it may save the eyesight and patience of fellow engineers.

Scope of Table

The table is based on a series of standard stirrup spacings. Each series of spacings with one size of wire corresponds to a definite load per lin. ft. of beam—that is, increase in shear per lin. ft. of beam. It is possible, for all practical purposes, to arrange the table with different sizes of wire and number of branch stirrups so that only a limited number of groups of spacings are required. In the table 14 groups are used. The shear taken by the concrete is taken care of by shifting the stirrups as a group away from the center of the beam.

Uniform Load

For example, we will design the shear reinforcement for a 12 by 20-in. beam, span 24 ft., load 2,000 lbs. per lin. ft. The top row of figures is used for both the depth of the beam in inches, and the span in feet.

We read under "20," depth of the beam in inches, "24" the end shear in kips; then move horizontally under "24," the span in feet. We then deduct for the shear taken by the concrete by moving toward the upper right corner (each space between horizontal lines represents 4 in. of beam width) until we rise through three horizontal spaces. Then follow the vertical down to the group of spacings corresponding to the size of wire used, and read the spacings to the right of the vertical.

For instance, if we use $\frac{3}{8}$ stirrups we take group G, $\frac{1}{2}$ stirrups group J, double $\frac{1}{2}$ in. stirrups group L. In this example if $\frac{1}{2}$ in. stirrups are chosen, we would have 6 at 6 in., 3 at 9 in., 2 at 12 in., and 1 at 15 in.

To determine which of the 14 groups (A to N) are to be employed in selecting the stirrup spacing, refer to the dotted diagonal line previously drawn to represent deduction of the shear taken by the concrete. Continue the diagonal line to the upper right-hand corner of the chart. The line so drawn passes through the group letter to be used for each size of stirrup. The curved lines, of course, inclose the groups for each size of stirrup.

Concentrated Load

If, instead of a uniform load, we had concentrated loads, it would not be necessary to move horizontally under the span. Merely deduct, as before, for the shear taken by the concrete, and follow the vertical to the corresponding group of spacings and use only the first spacing from the support to the first load, and then repeat the same operations from the first load to the second, and so on.

Due to the limitation of the size of the table, when beams exceed 42 in. in depth, compute V/d and move horizontally under the span, and then proceed as before.

The table may be used for multiple branch stirrups, different size wire, or different stresses by direct proportion. If anyone is interested in these features the writer will gladly explain the operations.

The above described operations may appear complicated at first, but after one becomes familiar with the table he will find that the stirrups for the average beam may be completely designed in less than one minute. Aside from the ease of design, standard stirrup spacings may be of interest because of the increasing use of welded stirrups.

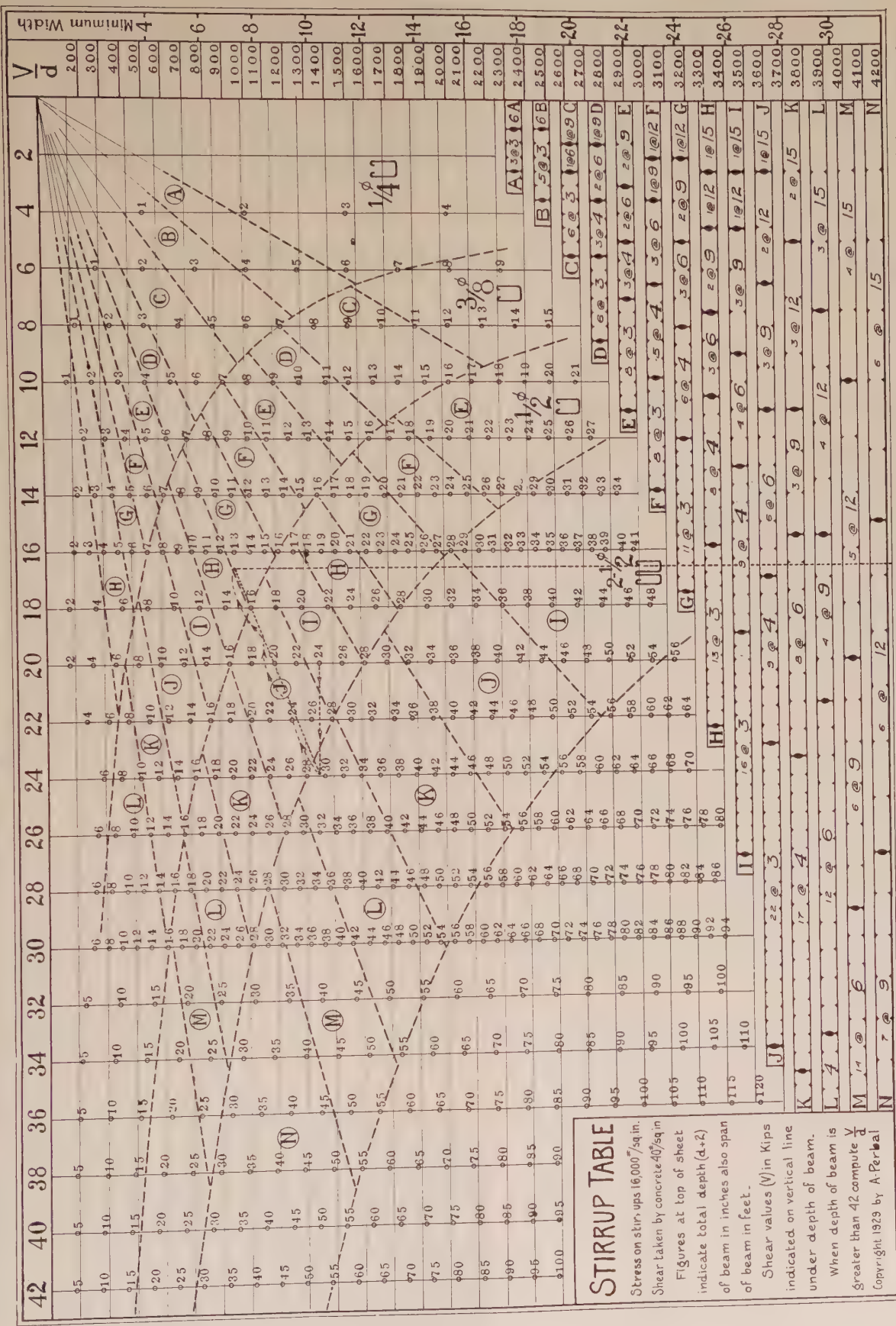


Chart for determining size and spacing of stirrups in reinforced concrete beams

Profitable Manufacture of Concrete Building Units

Differences in Pallets—Comparison Between Manual and Mechanical Handling of Product From Mixer to Stock-Pile—Importance of Correct Kiln Insulation—Value of Heated Mixing Water

VIII—Mechanical Manufacturing Problems

Part II

By FRED A. SAGER
Consulting Industrial Engineer

Assuming the moderate daily production of 1,200 units, Fred A. Sager compares types of pallets, handling of the product under various arrangements, and calculates economical kiln operating methods.

With the present close figuring of operating expenses, his recommendations deserve the close attention of the products manufacturer.—The Editors.

OTHER mechanical problems in manufacture have to do with the handling of the product from the machines to the curing and the storage space and the matter of curing the product.

In general, the handling of the product is the matter of handling the given tonnage in the most economical, practical method. In the case assumed, with a production of 1,200 units per day, if the product fresh from the machines is taken at 40 lbs. per unit, the tonnage handled to the curing rooms will be 48,000 lbs., or 24 tons, for cinder concrete units, and proportionately larger for units using sand and gravel aggregates.

The usual general considerations apply to this case as to any other tonnage movement problem, modified possibly by the requirements for careful handling of the fresh product, and the various methods of curing. In general, hand handling is the more expensive, and cost can be reduced by some method of mechanical transportation.

In any case the unit must be received from the machine on the pallet. The thickness of the pallet is of importance when considering the storage space necessary for pallets not in use and as well when considering the space required in the curing kilns. For the given output of 1,200 units per day, a fair estimate of 8-in. pallets would be 2,500. If of wood and piled 5 ft. high, they would require storage space of 8 ft. by 7 ft. 6 in.; if of iron, $\frac{1}{2}$ in. thick, space 4 ft. by 4 ft. 8 in.; if of steel, $\frac{1}{4}$ in. thick, space 3 ft. 6 in. by 2 ft. 8 in.

On the score of space occupied, the steel pallets rate far above other types, and in sizes for which they are adapted, this feature is to be given consideration. In the matter of weight the wooden pallet has the advantage, but on account of the space required and durability of iron and steel pallets, the latter are now generally used.

Storage space must be provided for pallets not in use, and this may well be located on the return route of the racks from the finished stock storage, to the machines, since this will allow change of pallets, with change in unit produced, with least interference with regular operating routine. The man yarding blocks has to stop on his return trip from the yard and exchange the pallets on the empty rack, and if working on a close yarding schedule, may need assistance in the way of part time of other operators. Usually the change can be handled without assistance from others.

Handling from Machine to Curing

Methods of handling block from machine to curing space include carrying by hand, placing on racks, which are taken to curing space by lift truck, or on own wheels on track, or by gravity conveyor. As noted above, it was anticipated that hand delivery would be most expensive, and with an output of 1,200 units per day this proves to be the case, with the usual plant layout.

It must be noted at this point that the whole movement from machine to finished storage should be considered, and this involves the type of curing facility, its location and age. With moist air storage and the 4 to 5 days required before yarding the product, space for 5 or 6 days' run must be provided, which means 3 or 4 times the area required for kiln curing, and a longer average haul from machine to curing storage. In case of carrying by hand, at least one and probably two additional offbearers will be needed at an annual cost of about \$1,700 per man. If the units were placed on racks at the machine, and racks transported to curing storage by lift truck, costing in the neighborhood of \$1,000, the labor saving of a few months would pay for the entire equipment. With kiln curing, and a shorter average carry from machine, the rack and truck equipment will soon pay for itself.

In some plants a variation of this method is provided for by moving the machines to the kilns or curing storage

space, in which case provision has to be made for handling the concrete from the mixer to the machine. The problem of transporting the material is not eliminated, but simply shifted as to form of material transported. The additional equipment has to be provided both to deliver the raw concrete and to move the machine from point to point as well. With the machine placed in the kiln, an extra off-bearer is usually required, with additional labor cost that would more than justify the investment cost of racks and trucks.

Use of Gravity Conveyors

In some plants gravity conveyors are used to handle the product from machine to curing storage. With such conveyors one offbearer at the machine should suffice, but a second man must receive the product at the delivery end of the conveyor and place the product in curing storage, which again points to the economy of racks and trucks.

When racks and lift trucks are not used, the product is often stored for curing on an arrangement of portable shelves supported on 2 by 8-in. spacers, built up 9 or 10 courses high. In all such operations it appears that the cost of getting the product from the machines to the curing storage is higher than by use of racks and lift truck as noted above. In addition the cost of handling from curing storage to finished storage is also higher as the product has to be handled out of curing storage and into finished product storage by hand, a total of three hand handlings after leaving the machine. With racks the units are not touched by hand until finally placed in finished stock storage.

Comparative Costs

At first it might appear that considerable expense in the matter of racks and trucks is eliminated by manual handling. While racks of 100-unit capacity may cost from \$60 to \$100, the simplest portable frames will cost \$12 per 100 units, which must be figured as a credit or offset in estimating the cost of racks and lift trucks for the other method of handling. It then appears that the usual method of delivering the fresh unit from the machine directly to the rack, to curing storage and later to finished storage on racks carried by lift trucks, is the most economical plan for the moderate sized plant. Even the advantage as to space occupied claimed for portable shelves in kilns may be questioned as in general about 1 cu. ft. of kiln space per 8-in. unit is used in this method, while with proper design of racks, the kiln space can be kept down to less than 1.2 cu. ft. per unit.

Portable vs. Stationary Racks

As to the use of larger racks mounted on wheels with transfer tables, or stationary racks with lift trucks, in large plants the former may show greater economy, when installed in a well designed layout. The lift truck and portable racks give greater flexibility so far as placing and storage of empty racks is concerned. This is a worthwhile factor in the moderate size plant, operating with a limited number of men, some of whom have to split their time between the various plant operations.

With the product handled on racks, the transfer from curing space to finished stock storage is practically the reverse of the movement into curing space. The rack is moved into the yard, where it is unloaded by hand onto

the stock-piles. With racks on wheels, running on rails, the carry from rack to storage is usually longer, on the average, than when portable racks are used with lift trucks. With the latter, main runways of concrete should be provided, furnishing permanent ways between storage piles.

Portable wooden runways may well be used to permit the rack being placed at any point along the face of the stock-pile then building, so that the units may be handled from the rack to stock-pile without extra steps.

When it is realized that with a labor rate of 75 cents per hour, the simplest handling of an 8-in. unit costs from .15 to .3 cents, and that a long carry may increase the cost of the same apparently simple handling to twice this amount, the importance of convenient working conditions becomes apparent.

Limit of Manual Handling

Where the product is stored in kilns on portable shelves, two hand operations are required to get the product from kilns to stock-pile, which as previously mentioned is to the disadvantage of this method so far as costs are concerned.

For the ordinary plant the unit should be placed by hand on the rack, and not be handled again as a unit until the unit is separated from the pallet and put in the stock-pile.

At this point the pallets should be placed in the empty rack, which will return them to the plant where the piles of pallets can be placed at the hand of the block machine operator as needed. With from 20 to 24 tons of the product to be handled each day, the two necessary handlings by hand are all the business will stand.

CURING THE PRODUCT

The fresh product delivered by the machine on the pallet must be cured before it can be removed from the pallet and placed in stock storage. This is done in moist air storage or in steam kilns as the case may be.

With moist air storage the blocks are ordinarily kept on the pallets 4 or 5 days, while with steam curing one day is sufficient, in ordinary seasons, and two days in severe winter weather. The kilns and steam equipment involve additional expenditure for plant, but this is offset by a lower expenditure for pallets and racks and curing storage space. Also, the steam curing plant may be less in first cost.

If a five-day moist curing plan is assumed with the output of 1,200 units per day, 7,200 8-in. pallets and 72 racks of 100-unit capacity would be required, and not less than 1,250 sq. ft. of curing storage space. With steam curing 2,400 pallets, 24 racks and 550 sq. ft. of kiln space would suffice. This indicates a saving of over \$4,000 in pallets for 8-in. units only and in racks, which would provide for the installation of kilns and heating equipment. Were the excess pallets for other units considered the saving would be larger. This comparison assumes real moist curing, for the full period.

Many plants use a shorter period, and the total number of pallets required could be reduced by a production scheduling a shift from one unit to another within the curing period. This, however, at times limits the output of an unusual run on one size of unit.

The advantages of steam curing, including uniformity

of product, under varying weather conditions, are sufficient to make this method quite general in the better plants, notwithstanding the additional operating cost for fuel and upkeep of the steam plant.

Proper Kiln Construction and Use

Utmost kiln efficiency is best attained when space is as fully occupied by the units as is practicable, and when the insulation of the walls is high.

Where racks are used the first condition is dependent on the design of the racks. With the use of steel racks proportioned properly for the kilns a very compact arrangement of the units in the kiln can be obtained and lost space in the kiln reduced to a minimum.

The insulation of the kiln walls should be provided for in the interest of operating economy. Some plants are now using cork insulation for the walls and any plant with brick or stone concrete walls could well consider such additional insulation. Cinder concrete and haydite walls, if waterproofed, should give reasonable insulation and would operate with good economy.

The coefficients for heat transmission of .33 for cork, 1.62 for haydite, 1.77 for cinder-concrete, 4.00 to 5.00 for brick walls and 6.25 to 8.00 for stone concrete indicate what may be expected of these materials.

To indicate more closely the nature of the problem the case of a single kiln 7 ft. wide by 6 ft. high and 32 ft. long may be considered.

Calculating Heat Required

Assume that the side walls, top and bottom of the kiln are 8-in. cinder and that the end doors are of two or three layers of celotex or equal insulation. One thousand 8-in. cinder block are placed in the kiln at a temperature of 65 deg. F. which is raised by steam to 125 deg. F. With a bone-dry weight of 30 lbs. per block, carrying 10 lbs. of water each and with .2 specific heat for the dry block, 390,000 B.t.u. are required to raise the temperature of the dry block and 650,000 B.t.u. to raise the temperature of the water carried by the block a total of 1,040,000 B.t.u. for the 1,000 wet block fresh from the machine. The 135 pounds of air in the kiln would absorb 1,625 B.t.u., but this may be disregarded. If live steam is delivered to the kiln the air should be allowed to escape and its space filled with water vapor or steam.

The walls of the kiln will also be heated and if they are brought up to the same temperature they would absorb an additional 455,000 B.t.u. if made with cinder concrete, 830,000 B.t.u. if brick, and 1,160,000 B.t.u. if made of stone concrete. As a matter of fact the entire wall of the kiln will not be raised to this temperature, since there will be the normal drop in temperature from the kiln temperature on the inside face of the wall to near the outside temperature on the outer face of the wall.

For estimating roughly, the average temperature raise of the kiln walls may be taken as one-half that of the product in the kilns. If one-half the above amounts for heating the walls are added to the 1,040,000 B.t.u. required to heat the block the totals will be 1,267,000, 1,455,000 and 1,621,000 B.t.u. respectively for heating the 1,000 units and the kiln with walls of cinder block, brick or stone concrete. Figuring 970 B.t.u. per lb. of

steam and 5 lbs. of steam per lb. of coal, there will be required 262, 301 and 336 lbs. of coal to heat up the respective kilns.

Waterproofing Kiln Walls

Next, figuring the loss of heat by conduction through the kiln walls, it appears that with 125 deg. temperature on the inside and 65 deg. temperature on the outside of the 8-in. kiln wall, about 9,500 B.t.u. loss will occur for cinder block or haydite walls, and about 20,000 B.t.u. for stone concrete walls. If the walls of the cinder concrete or haydite kilns are wet or damp, insulation would be greatly reduced. The same is true of brick and stone concrete. For this reason kiln walls should be thoroughly waterproofed in construction.

A lining of 1½ in. of cork or celotex, also waterproofed, would increase the insulation of the concrete wall to approximately that of cinder concrete or haydite. With walls so insulated, once the product is brought up to the desired curing temperature, practically no more heat will be required. In fact, with tight kilns the heat could be cut off and the product allowed to soak in its own heat for 23 hours with a reduction of about 20 per cent in the B.t.u. delivered to the kiln, or a temperature drop from 125 deg. F. to, perhaps, 110 deg. Likewise, with tight kilns there would be no question as to sufficient moisture and the expense of steam curing will be well within economical limits.

Heated Mixing Water

Another significant point is evident from the above consideration, when the amount of heat required to raise the water content of the block is noted. If the mixing water used in the plant were heated, particularly in cold weather, not only would the unit be insured against freezing in a cold plant, but a considerable portion of the heat required in the kiln could be supplied in advance.

Length of Heating Period

From a consideration of the specific heat of the block, and its comparatively high conductivity when wet as it comes from the machine, it appears that when immersed in a bath of live steam, assuming the kiln practically free of air, the unit should heat up in a comparatively short time, say 20 or 30 minutes. The dry walls of the kilns will heat up more slowly, and therefore with cold kilns the steam should be kept on until both product and kiln walls have reached the desired temperature, after which a very small additional supply of heat will suffice for the curing process.

In these approximations a single kiln has been considered. With the usual arrangement of kilns alongside each other, the losses through the walls will be decreased, particularly when adjacent kilns are in operation at the same time.

The essentials for economical kiln construction may be summed up as high insulation in the walls and tight fitting doors, the first to retain the heat, and the second to maintain the steam or water vapor. It is believed that with such kiln construction, the curing temperature can well be raised from the usual 125 deg. to nearer 200 deg. with a corresponding increase in the 24-hour aging or curing of the product.

Accurate Control of Concrete Work Applied to Small Contract

Contractor Tells of Faster Work and Better Concrete
Than Under Old Methods—Simple Weighing and Meas-
uring Equipment in Tennis Court Construction

By IRA M. HOLE
Concrete Contractor, Deerfield, Illinois

HAVING heard of the many advantages to be obtained from accurately controlling the various materials used in making concrete, I was rather pleased to get the contract recently for two tennis courts awarded by the Park Board of Glencoe, Illinois, in which the specifications called for weighing the materials and measuring the water. I felt that this contract would give me an opportunity to check the advantages of accurate control on the job. It did, and I feel that other contractors might like to know of the success we had on this contract.

No Difficulty About Quality Control

Not having tried accurate control methods, I thought at first that the work might be slowed down and that costs would be higher than if I had used what I now know to be old-style methods. My first guess was wrong because there was no delay getting the materials to the mixer and, in addition, the batches were more uniform than any we had made on previous jobs. This uniform concrete was workable without separation of the materials in wheeling. My men were able to work the concrete into place with less effort, and, at the same time, they had less difficulty in striking off.

The concrete was uniform in all sections of the courts, and there were no low places which needed filling or high spots that required a lot of floating to work out. Part of this improvement in the concrete was due to having the proper proportions of sand and gravel.

Making the Trial Batch

The engineers, Windes & Marsh, of Winnetka, Illinois, had prepared the plans for this tennis court job as shown in the drawing. They also helped to work out a mixture that would be best for the materials to be used on the job. Their specifications called for the use of not more than 6 gal. of water with each sack of cement, including the water contained in the sand. In addition to the help from the engineers, a booklet, "Concrete Facts for Concrete Contractors," issued by the Portland Cement Association, was found useful. Among other things, it told how to make what is known as a trial batch on the job.

To coat the drum and blades with mortar, several batches of 1:2:3 concrete, with just enough water to make a stiff yet plastic mix, were run through the mixer. This was done because, ordinarily, the first batch mixed will be somewhat stiffer than the second or third batch, as some of the water in the first is used in wetting the mixer drum and blades.

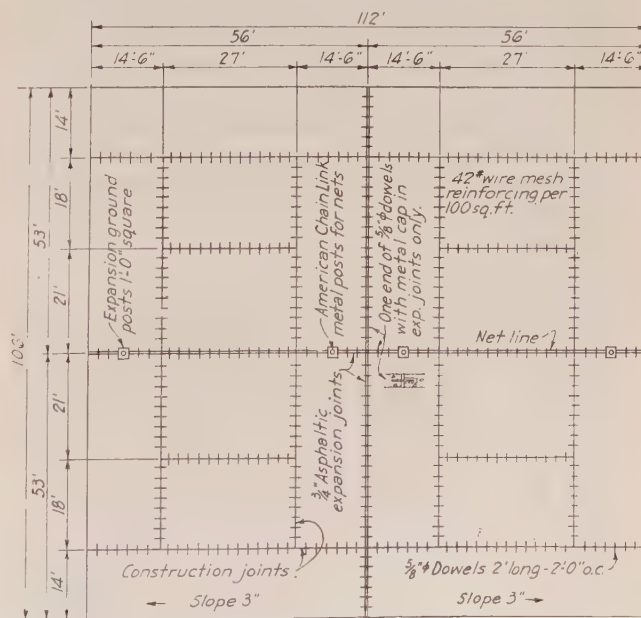
After the mixer was ready, 5 gal. of water, measured

with a 10-qt. pail, were placed in the drum with 1 sack of cement. Only 5 gal. of water were needed to make a 6-gal. cement-water paste, because the sand was wet and carried about $\frac{1}{2}$ gal. of water per cu. ft. The 2 cu. ft. of sand, which were used in this trial batch, of course,



Forms for tennis courts, with dowels in place at expansion and construction joints

carried about 1 gal. of water. Next, sand and gravel were put into the paste to stiffen the mix. Slightly less than 2 cu. ft. of sand and 3 cu. ft. of gravel were used at first. Then small amounts of each were added until



Plan of concrete tennis courts, showing location of expansion and construction joints

the batch was right—that is, of a consistency suitable for placing in tennis court work. Since a rather stiff concrete could be placed, enough sand and gravel was used to get the desired stiffness.

The aggregates (sand and gravel) for the trial batch were taken from wheelbarrows which contained known weights of materials. Then by weighing back the sand and gravel left in the barrows, after the trial batch was made, we knew how many pounds of each to use in each succeeding batch made with the same materials.

Adjusting the Mixture

On the second day's run the sand was somewhat coarser than that used the day before, making it necessary to add an extra 10 lb. of sand. This additional sand made the concrete easier to finish.

Small changes of 10 to 15 lb. of either sand or gravel, we found, will not affect to a great extent the cement-water paste which determines the quality of the concrete.

It was interesting to note the effect of adding sand and gravel to the mix in making the trial batch, in that these materials changed the workability of the concrete.



Batching sand and gravel by weight. Platform scales under each runway permitted workmen to make slight adjustments in weight before delivering to mixer

Gravel, of course, added to the volume of concrete, yet adding too much of it made the mix harsh and hard to work. This condition was corrected by adding more sand when the mixture was not too stiff. If sand stiffened the mix too much, then slightly less sand and less gravel were used in the next batch.

Simple Methods of Weighing and Measuring

How to weigh materials and measure the water proved to be problems that were easy to solve. Water was measured with a bucket which had been measured and marked accurately by using a 1-qt. milk bottle. Each time a quart of water was placed in the pail, a mark was scratched on the side of the pail at the water level. Later the scratches were painted to give permanent marks for quick measuring. On this particular job, it so happened that 5 gal. of water was the right amount and measuring was done with a 10-qt. pail, this being filled twice for each batch.

Weighing aggregates was accomplished quickly and economically by placing a 1,000-lb. capacity platform scale under each runway (see the accompanying photograph).

The men wheeling sand and gravel stopped at the scales and weighed the materials on their way to the mixer. The weighing was done during the usual waiting time between batches, and, in this way, whatever small adjustments were necessary to get the correct weight were made without any loss of time.

A Good Sales Argument

The cost of weighing equipment, I figure, will soon be paid for in reduced labor costs of placing and finishing, to say nothing of the time saved in the finishing work. In addition to speeding up the work and improving the quality of the concrete, I have a good sales argument to put up to my prospects, now that I am batching materials by weight and measuring water. I can guarantee quality work by controlling accurately the concrete that is placed on each job.

P. C. Building Officials to Consider New Chapters to Code

Pacific Coast Building Officials to Meet at Berkeley, Calif., in October

Building code development and enforcement are stressed by the Pacific Coast Building Officials' Conference in the program for its tenth annual meeting, to be held at Berkeley, Calif., October 5 to 10, inclusive. Program features announced by the president, S. P. Koch, chief building inspector of Berkeley, include papers on subjects of practical, every-day interest, breakfast discussions dealing with problems of the building inspector, and committee work on code maintenance.

The most important achievement of the Pacific Coast Building Officials' Conference has been the preparation and publication of the Uniform Building Code for the use of interested cities.

At each annual convention the code is reviewed and proposed changes discussed and recommended with the object of keeping the provisions correct, up to date and unbiased in conformity with the latest and best modern practice and research findings. At this year's convention nearly two days' time will be devoted to code maintenance work. Two new chapters will be considered, one concerning termite and fungus control, the other dealing with licensing contractors. The first is being prepared by the Termite Investigations Committee of California from data resulting from several years of study, research and experimentation.

Four breakfast discussions of two hours each have been provided for to allow building inspector delegates to ask questions on building code interpretation and enforcement.

Papers scheduled include the following, among others: "Building Material Specifications and Tests as They Affect the Building Inspector," by Frank L. Howard, testing engineer, Smith-Emery Co., Los Angeles; "Fire Zones from an Underwriter's Standpoint," by L. S. Bush, chief engineer, Board of Fire Underwriters of the Pacific; "Condemnation of Buildings," by C. D. Wailes, Jr., chief building inspector, Long Beach, Calif.; and "Model Termite Control Ordinances," by Earl E. Bowe, executive secretary, Termite Investigations Committee of California.

Transverse and Longitudinal Joints in Concrete Highways

Wide Variation in Practice, Both as to Types of Joints and Intervals Between Them—Joint Fillers Also a Problem

This concludes the series of articles on highway construction methods and practices, started in the April issue of "Concrete" as the result of inquiries addressed to state highway officials.

Full credit is due the many state highway engineers who contributed the discussions upon which these articles are based, for the exchange of ideas and the methods presented will aid in the improvement of concrete highway design and construction.

It is with pleasure that "Concrete" has served as the medium for the exchange of these ideas.—The Editors.

IN several respects the problem of transverse expansion joints in concrete highway construction is now receiving more studious attention than in former years, according to letters received from a number of state highway engineers in reply to inquiries addressed to them.

The realization that joints are deserving of more careful consideration has been well expressed by T. H. Cutler, Chief Engineer, Missouri State Highway Department, in his report on the Mississippi Valley Conference of State Highway Departments, in the June issue of CONCRETE, pages 33-34.

Variation in Practice

The statements there made will bear repetition. "Nearly all states," Mr. Cutler says, "feel the need of, and are building, contraction or expansion joints for the protection of the concrete slab. However, there is a wide variation in the practice, especially as to the spacing of the joints and their width."

Again, in the same article, Mr. Cutler says, "Poured material seems to be favored over pre-molded mastics, with considerable sentiment apparent for the development of some form of practical air joint."

Great Variation in Practice

Returning, now, to the replies to the questionnaire of CONCRETE, it must be admitted that the statement concerning the "wide variation in practice" is fully verified. One state specifies transverse joints at intervals of 40 ft., another at intervals of 800 to 1,000 ft. A third provides no transverse joints at all, merely filling the cracks that naturally develop. There is further variation in the manner in which joints are constructed.

Cellular Rubber Expansion Joint

A type of expansion joint described by C. H. Purcell, State Highway Engineer for California, is interesting. "For expansion joints," he writes, "a cellular rubber joint is specified, which has the property of returning approximately to its original size upon compression, and absorbs but little water. Metal end holders or pockets are nailed to the wooden headers, and heavy joint holders with tooth sides are used to avoid displacement of the joint during concreting. A light channel iron is placed over the joint filler during the process of finishing the pavement surface. We use an edging tool and brush for the final finishing at joints."

Saddle of Burlap Insures Efficiency

In Arizona, writes J. W. Powers, Engineer of Materials, State Highway Department, "the present standard method of joint construction for pavement calls for a saddle of burlap over the joint to hold it down against the subgrade. It also helps to keep fresh concrete from flowing



Cutting a longitudinal dummy center joint with a T-iron

under the joint, thus giving the joint 100 per cent efficiency."

Different Methods of Joint Construction

From another mountain state, H. S. Kerr, Chief Engineer, Utah State Road Commission, reports that no definite distance between expansion joints is specified. Such joints must be provided as shown on the plans, and the joint filler must be inserted by an approved installing device.

Mr. Kerr (Utah) also states that dummy joints are provided wherever shown on plans. The dummy joint is cut with a heavy T-iron immediately following the final floating. The groove thus cut is then filled to within $\frac{1}{4}$ in. of the surface with a pre-molded joint filler, by means of an approved installing device. The surface along the joint is then refinished.

In Oklahoma, says Guy H. James, Assistant Construction Engineer for the State Highway Commission, an open transverse joint filled with asphalt is built at intervals of 100 ft., with dummy joints $2\frac{1}{2}$ in. deep at the midpoint between the open joints.

In Oregon, writes S. H. Probert, Office Engineer, Oregon State Highway Commission, the ordinary longitudinal center joint is provided. Expansion joints $\frac{1}{2}$ in. thick are spaced at 60-ft. intervals, while contraction joints occur at 20-ft. intervals.

Somewhat typical joint construction is described by W. W. Zass, Engineer of Construction, Arkansas State Highway Commission. "It has been our practice," he says, "during the past few years to use poured transverse

made by a metal strip. Longitudinal joints are doweled, and transverse joints are doweled with eight $\frac{3}{4}$ -in. bars wherever subgrade conditions are believed to require it, says L. M. Dinsmore, Office Engineer, State Highway Department.

Longer Distance Between Joints

A tendency toward greater distances between expansion joints is seen in several states. "In Michigan," writes C. M. Ziegler, Construction Engineer, State Highway Department, "we call for 1-in. expansion joints every 100 ft. We use pre-molded expansion joint filler and insert this in the pavement during construction."

The Texas State Highway Department, according to Gibb Gilchrist, State Highway Engineer, "is making paving slabs longer and using joints 2 and 3 in. in width, with no dowels.

Illinois has for two years "placed 4-in. transverse joints at intervals of 300 to 1,000 ft.," writes C. M. Hathaway, Engineer of Construction, Division of Highways.

No Expansion Joints

North Carolina and Indiana are two of the states that provide no transverse expansion joints, except in certain places. From the former state W. E. Hawkins, Construction Engineer, North Carolina State Highway Commission, writes that their pavements are built without joints, tie rods being used only in the construction joint when work stops at night.

Wm. J. Titus, Chief Engineer, Indiana State Highway Commission, states that "we use only the center metal parting strip to form a longitudinal joint, and we provide a butt construction joint at the end of each day's run. Expansion joints are constructed only at the ends of bridges."

Of course, in states where expansion joints are omitted or placed at long intervals, the practice is to depend on the concrete slab to develop transverse cracks; after which the cracks are filled with a joint filler.

In spite of the great variations in methods of handling transverse joints, it can be said that in most cases the results are satisfactory. Each state highway department has worked out its own joint problems, in many cases without special regard to practices in other states. Nevertheless, uniformity in practice would be preferable to the present variation.



Installing a transverse air cushion metal expansion joint in Connecticut

joints exclusively, which construction is accomplished by fitting a steel template in the forms when the concrete is placed, finishing over it, then removing it after the concrete has attained its initial set."

The State of Washington requires a through joint at intervals of 40 ft. and a dummy joint midway between the through joints, according to T. G. McCrory, Chief Engineer, State Department of Highways.

Alabama provides transverse expansion joints $\frac{1}{2}$ in. thick at intervals of 40 ft., and a longitudinal center joint

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HOW TO DO IT

♦ Questions and Answers ♦
Consultation and Comment

A department devoted to the solution of problems encountered in concrete work. Readers are welcome to add to or improve upon the suggestions printed and to submit their views for possible publication.

Proportions and Colors for Concrete Brick

What proportions are generally used in the manufacture of concrete face brick, and what cement colors do you recommend to produce a reddish brown effect?—B. E. Z., Paterson, N. J.

The proportions of cement, aggregates and water will of necessity vary with the kinds of aggregates employed, but will probably be somewhere near 1 sack (1 cu. ft.) of cement, 2 cu. ft. of sand, 3 to 3½ cu. ft. of pea gravel or of crushed stone not larger than the ½-in. size, and 6 gal. of water.

The sand should contain no sizes smaller than the 30-mesh sieve, because very fine sand has been found harmful. Some manufacturers use sand as small as the 50-mesh sieve.

With the materials you have at hand you may find it necessary to make slight changes from the above proportions, in order to get a workable mixture; but the proportions given will be a good start for experimenting.

In the case of face brick, mineral colors must be added. Ask the manufacturers of cement colors listed in the classified index of each issue of CONCRETE for their suggestions on kinds and amounts of colors needed.

As an example, the following formula (for a rich reddish brown concrete) is given on page 46 of the January (1931) issue of CONCRETE:

Ordinary gray portland cement.....	88 parts
Manganese dioxide	4 "
Ferric oxide	6 "
Ferroso-ferric oxide	2 "
Total	100 parts

However, each manufacturer can give you his own recommended color formulas for any color effects desired, because he knows what his colors will do.

Walls of Concrete Block and Tile

Where can I get data on concrete block or hollow tile in the wall? How high may the wall be, and how much load may be placed on it?—W. J. O., Phoenix, Ariz.

The information you want is contained in two publications issued by the U. S. Department of Commerce Building Code Committee, known also as the Hoover Building Code Committee.

The use of both hollow concrete block and hollow clay units in walls is covered in one of those publications, entitled "Recommended Minimum Requirements for Masonry Wall Construction." This booklet contains recommendations as to wall thickness and height, as well as the allowable loads that may be placed on walls of this construction.

A more recent publication issued by this same committee, entitled "Recommended Minimum Requirements for Fire Resistance in Buildings," is abstracted on pages 23 and 24 of the June (1931) issue of CONCRETE. It establishes the thicknesses required for walls and partitions of hollow concrete masonry units for various periods of fire resistance, from one to four hours.

Copies of the former publication can be obtained at 15 cents each, and the latter at 10 cents each, from the superintendent of documents, Government Printing Office, Washington, D. C.

Strength of Concrete 12,000 Lb. Per Sq. In.

A statement was made at a meeting of the local engineers' club that specimens of concrete recently taken from the reinforced concrete structure in Chicago known as Wacker Drive tested 12,000 lb. per sq. in. in crushing strength. Can you verify this statement for me, and what is the age of the concrete?—J. D. R., Oklahoma City, Okla.

The concrete to which you refer is described fully in an article in the April (1931) issue of CONCRETE, pages 15 and 16. The average strength of six specimens cut from the Wacker Drive superstructure was 11,400 lb. per sq. in., the strength having ranged from 10,200 to 12,700 lb. per sq. in.

The age of the concrete was 46 months.

Concrete Brick in Chimneys

Will fire insurance rates on a building be increased if concrete bricks are used instead of clay bricks in the construction of chimneys?—C. E. J., Etna Green, Ind.

The Western Actuarial Bureau, of Chicago, is the fire insurance rate-making organization that covers some 20 states, including Indiana. They have informed us that in the territory coming under their jurisdiction concrete brick are classed with other brick so far as insurance rates are concerned, and no difference is made in fire insurance rates.

Concrete Fence Posts

Do you have available any publication dealing with the manufacture of concrete fence posts?—E. J. C., Plymouth, Ind.

The Concrete Publishing Co., 400 W. Madison St., Chicago, has published a paper-covered booklet entitled "How to Make and Sell Concrete Specialties," in which one chapter is devoted to reinforced concrete fence posts.

New Books and Pamphlets

Design of Rigid-Frame Bridges

THE RIGID-FRAME BRIDGES, first edition, 1931. By Arthur G. Hayden. Published by John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London. Cloth binding, 236 pages, 6 by 9 in., illustrated. Price \$4.50.

The author is well known as the chief designer of the famous rigid-frame reinforced concrete bridges of the park system of Westchester County, New York. The book contains the development of the design formulas for concrete bridges of that type.

In addition to chapters on the fundamental theories and formulas involved, there are chapters on actual design calculations for the following types of structure:

- (1) Symmetrical single span concrete frame bridge, free end conditions.
- (2) Symmetrical single span concrete frame bridge, fixed end conditions.
- (3) Unsymmetrical single span concrete frame bridge, free end conditions.
- (4) Symmetrical double span concrete frame bridge, free end conditions.
- (5) Single span concrete skew frame bridge, free end conditions.

One chapter, contributed by Gilmore D. Clarke, deals with the architecture of short-span bridges. Another chapter, by Prof. George E. Beggs, contains a deflector analysis of rigid-frame bridges of high indeterminacy.

Golf Course Information

GOLF COURSE COMMON SENSE. By G. A. Farley. Published by the Farley Libraries, Cleveland Heights, Ohio.

This book, which devotes an entire chapter to "Concrete Construction," is a comprehensive non-technical treatise on the subject of golf course maintenance. Its text suggests walks, driveways, steps, porch floors, soil-saving dams, retaining walls, engine and building foundations, hot beds and cold frames, refuse burners, cisterns, lawn rollers, humus pits, driving tees, tee boxes, tee benches, culverts and fence posts as being "the essential uses of concrete around the golf grounds."

The concrete construction information given includes facts concerning materials, proportioning, mixing, placing, finishing and curing according to modern methods. There is a complete discussion of proportioning concrete according to the amount of water that is required to be mixed with each sack of cement.

Concrete Improvements

PERMANENT IMPROVEMENTS FOR HOMES, SCHOOLS, PARKS, PLAYGROUNDS AND INDUSTRIAL PLANTS is the title of a new 20-page publication issued by the Portland Cement Association, 33 W. Grand Ave., Chicago, Ill.

The booklet is 8½ by 11 inches in size and is extensively illustrated. The text and illustrations are grouped in sections under the headings "Concrete Around the Home," "Concrete Around School Grounds," "Concrete in Parks and Playgrounds" and "Improvements for Industrial Plants."

Organizations

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS; W. C. Markham, Executive Secretary, 1222-24 National Press Building, Washington, D. C.

AMERICAN CONCRETE INSTITUTE; Harvey Whipple, Secretary, 624 Fisher Building, Detroit, Mich.

AMERICAN CONCRETE PIPE ASSOCIATION; M. W. Loving, Secretary, 33 West Grand Ave., Chicago.

AMERICAN ROAD BUILDERS' ASSOCIATION; Chas. Upham, Engineer-Director, 914 National Press Building, Washington, D. C. Twenty-ninth annual convention and road show, January 9-15, Municipal Airport building, Detroit, Mich.

AMERICAN SOCIETY OF CIVIL ENGINEERS; Geo. T. Seabury, Secretary, 33 West Thirty-ninth St., New York City.

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CANADIAN ENGINEERING STANDARDS ASSOCIATION; 178 Queen St., Ottawa, Ontario.

CAST STONE INSTITUTE; L. A. Falco, Secretary, Chapel St. and Blatchley Ave., New Haven, Conn.

CEMENT INSTITUTE; Luther G. McConnell, General Manager, 11 East 44th St., New York City.

CONCRETE MASONRY ASSOCIATION; Jack Franklin, Secretary, 7071 Plankinton Bldg., Milwaukee, Wis.

CONCRETE REINFORCING STEEL INSTITUTE; M. A. Beeman, Secretary, Tribune Tower, Chicago. Semi-annual meeting, September 28-30, Buckwood Inn., Shawneetown-Delaware, Pa.

ENGINEERING INSTITUTE OF CANADA; 2050 Mansfield St., Montreal, Quebec.

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NATIONAL LIME ASSOCIATION; Norman G. Hough, Secretary and Manager, 927 Fifteenth St., N. W., Washington, D. C.

NATIONAL READY-MIXED CONCRETE ASSOCIATION; V. P. Ahearn, Secretary, 545 Munsey Building, Washington, D. C. Second annual convention, January 25-26, William Penn Hotel, Pittsburgh, Pa.

NATIONAL SAND AND GRAVEL ASSOCIATION; V. P. Ahearn, Executive Secretary, 545 Munsey Bldg., Washington, D. C. Sixteenth annual convention, January 27-29, William Penn Hotel, Pittsburgh, Pa.

NATIONAL SLAG ASSOCIATION; H. J. Love, Secretary-Treasurer, 937 Leader Bldg., Cleveland, Ohio.

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New Equipment and Materials

Scope and Design of Munsell Concrete Vibrator

Concrete on such jobs as the Bagnells dam, Bagnells, Mo., the Hudson river bridge, the Kill van Kull bridge, New York, and the Newark, N. J., subway was compacted and made more uniform by the Munsell vibrator, according to its designer, A. W. Munsell, 999 West Side avenue,



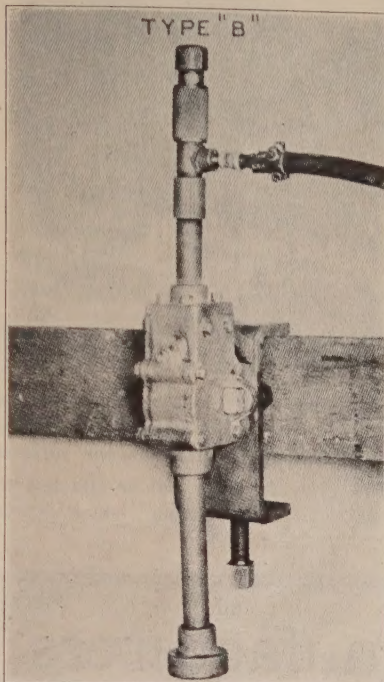
Jersey City, N. J. The vibrator is also usable on concrete products forms.

The tool is said to be the result of a study which showed the three main factors of such equipment to be the speed or vibration per minute, the amplitude of the blow, and the time of application.

The Munsell vibrator consists of an air-driven eccentric rotor with the number of vibrations controlled by the amount of air pressure. With 20 lb. of pressure, 1,000 vibrations per minute can be obtained, and with 85 lb. of pressure, 3,000 vibrations can be obtained.

The consistency of the concrete to be placed is the controlling factor in the number of vibrations to be used. For wet consistency (6-in. slump) a low speed (1,000 vibrations), and for dry consistency (2-in. slump) a higher speed (2,500 vibrations and upward), depending on the amount of water used and the size of the mass to be moved, is used.

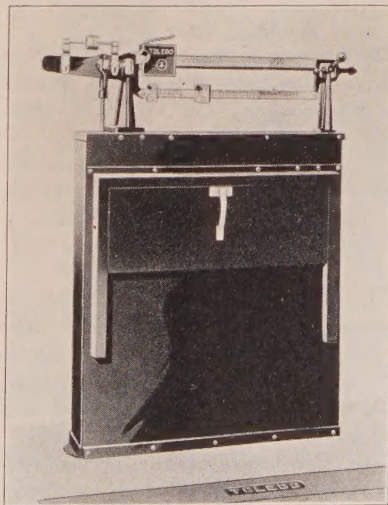
The equipment is made in two types. Type A is portable, with an overall length of 30 in. and a weight of 35 lb., and is equipped with a trigger valve for controlling the number of vibrations, to be used on slabs, beams or girders. Type B,



weight 40 lb., is of the same length but is equipped with a vise for clamping on forms and sleeve type valve for operating at one speed, for use on walls, mass concrete or concrete products forms.

Convert-O-Matic Scale Developed for Automatic Dial Indication Weighing

For the automatic weighing of materials in highway construction, the Toledo Scale Co., Toledo, Ohio, has developed a new type of beam scale. The Toledo Convert-O-Matic is said to enable users of heavy-duty weighing equipment to transform Toledo beam type scales to au-



tomatic dial indication with slight additional cost and no loss of production time.

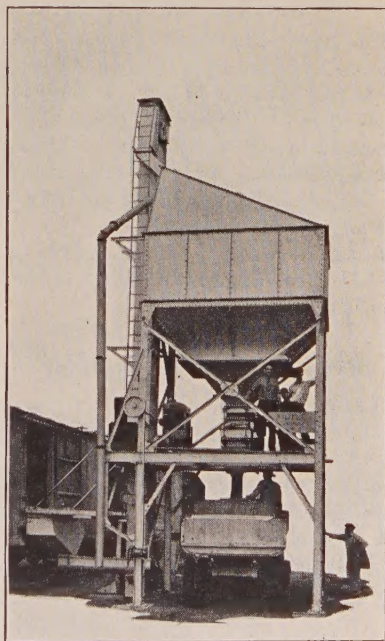
It has a full floating platform to stop losses caused by the wear resulting from movement of the knife edge pivots on the bearings. It is possible, at any time, it is claimed, to put on the Toledo Automatic Indicating dial with its full floating double pendulum mechanism, which has no pivots or bearings. Should requirements demand an automatic scale of greater capacity, a further adaptation of the Convert-O-Matic is possible. Its total weighing capacity may be increased one to four times merely by adding unit weights in the same cabinet.

Three sides of the cabinet are of one piece of pressed steel to give strength and stability.

Butler Automatic Weighing Batcher and Bulk Cement Plant Is New Unit

The Butler automatic cement weighing batcher and bulk cement handling plant is designed to accurately weigh the batch, eliminating the manual control, according to the Butler Bin Company, Waukesha, Wis.

A screw conveyor operated by an elec-



tric motor or gasoline engine conveys the cement from the storage bin to a hopper or container which is suspended in the weighing scale. The weight desired is set off on the scale beam. A push button starts the motor and screw conveyor de-

livering cement into the hopper and the correct weight is in the hopper, the motor and screw are automatically shut off by means of an electric contact, it is stated.

The discharge gate, controlled by the operator from the platform, regulates the rate of discharge of the cement from the hopper through a flexible rubber hose into the truck or cement container.

The Butler automatic cement weighing hopper will automatically weigh batches well within an accuracy of 1 per cent and will consistently weigh and discharge a batch up to 1000 lbs. in 45 seconds, it is stated.

New DeVilbiss Highway Striping Outfit Developed

A highway striping outfit, to be used for spray-painting a traffic line stripe on highways and streets, has just been perfected by the DeVilbiss Company, Toledo, Ohio.

This outfit is said to lay a perfect stripe at a speed of from six to eight miles an hour. About seven gallons of paint is



used for each mile of striping, depending upon the kind of material used, thickness of coating desired, and the surface.

The Type HS outfit can be attached to either right or left running board or can

be used as a trailer from the rear of a truck. While it is substantially built for its purpose, yet it is light enough for one-man handling in loading and unloading and attaching to truck.

The running board striper type is fastened to the truck by a clamping arrangement which also holds the horizontal draw bar in position. The design of the equipment permits of adjustment for various heights of running boards. The operation of the striper does not obstruct traffic. In intermittent striping, or in going from one job to another, the outfit can be lifted by chain or rope from the operator's position on the truck, thus permitting the driving of the truck at greater speed between jobs.

The trailer type striper is similar to the running board type, except that it has a vertical draw bar and bracket with clamping arrangement to clamp the draw bar at various heights, as illustrated. The bracket is bolted to the truck floor. The bracket adjustment permits of fastening and holding the striper in a level position on trucks of different heights.

About the Manufacturers of Equipment

Industrial Literature

Fuller-Kinyon Pump

The latest achievements of the Fuller-Kinyon pump are dealt with in the most recent publication, *Bulletin B-4*, of the Fuller Company, Catasauqua, Pa.

Equipment and installations covered are portable systems, for box cars, typical mixing plant layouts, highway construction and long distance conveying.

Transport system details are shown, as are also line drawings of the pump and plant layouts.

Ready-Mixing Equipment

Descriptions of Blaw-Knox steel storage bins, measuring equipment, ready-mixed concrete plants, and truck mixing and concrete agitating bodies are contained in *Catalog No. 1302*, issued by the Blaw-Knox Co., Pittsburgh, Pa.

Installations and uses are shown in numerous and excellent illustrations.

Medusa Waterproofing

The Medusa Portland Cement Company, Cleveland, Ohio, has issued an A.I.A. folder on Medusa waterproofing for concrete. This preformed integral waterproofing is a finely ground water repellent material, it is stated, and is recommended for

use where the Medusa waterproofed cements are not available.

Uses and specifications are given.

Butler Leaflets

New printed matter issued recently by the Butler Bin Co., Waukesha, Wis., includes a 4-page leaflet on the Butler automatic cement weighing batcher and bulk cement handling plant.

Another leaflet is *Folder F10*, on Butler steel bins.

Products Manual

A 4-page leaflet—"a condensed manual of live information on modern practice in the cement products industry"—has just been issued by *Abram Blue Ribbon, Incorporated*, Detroit, Mich., under the title of "*Efficient Manufacture of Concrete Masonry Units*."

Another leaflet of 8 pages is devoted to the Abram Blue Ribbon Ace model concrete block machine, whose construction and operation is described in detail.

Manufacturers' News

S. M. Chase Dies

The death of S. M. Chase, vice-president and general manager of the *Chase Foundry and Manufacturing Co.*, Columbus, Ohio, occurred on July 20.

Mr. Chase had been engaged in the business of building cars and racks for use in products plants for thirty years.

X-Ray Service

The Robert W. Hunt Co., Chicago, announces that it now has available to users of engineering materials an X-ray laboratory of the latest and most modern design. Details are available in the form of a 4-page folder.

This service, supplemented by the facilities of the chemical, physical, metallurgical, and photomicrographic laboratories, is

claimed to furnish a comprehensive means for the determination of internal defects.

With the facilities available, it is possible to X-ray material up to 3½ in. thick for steel and equivalent thicknesses for other materials proportional to their density.

Chain Belt Distributors

The Chain Belt Company, Milwaukee, has appointed two new distributors to handle its complete line of Rex mixers, pavers, pumps, saw rigs, plaster and mortar mixers, central mixing plants and other construction equipment. In Vermont it has appointed the *Vermont Road Equipment Company*, Montpelier, Vermont, and in Idaho the *Northwest Machinery Company*, located at 710 Front Street, Boise.